THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. XXV MAY, 1931 No. 5

THE ROENTGENOLOGIC DEMONSTRATION OF POLYPOID LESIONS AND POLYPOSIS OF THE LARGE INTESTINE*

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ALMOST all organic diseases of the large intestine produce deformity in the contours of the lumen of the affected segment. By the application of the roentgenologic methods and observations of Haenisch, Stierlin, Schwarz, Carman and Miller, and Fischer,[15] preëminent names among those who have devoted special attention to the roentgenologic manifestations of diseases of the colon, it is possible not only to demonstrate this deformity, but also, from a study of its characteristics, to distinguish the various types of lesions from each other. Because it furnishes rich contrast, and because of the reliability of the diagnostic data which it yields, the opaque enema has been the method of choice for demonstration of the distinctive features of deformities produced by disease.

Polypoid lesions of the colon, however, cannot be depended on to produce a roentgenologically demonstrable deformity in the lumen of the colon. For want of a better term to embrace the heterogeneous group under consideration, the term "polypoid lesion" is used in its broad sense to include any sessile or pedunculated growth projecting into the intestinal lumen without special reference to the histologic nature of the tissue of which it is composed. Saint and others have pointed out that such an intraluminal growth may take origin from any one of the tissue elements of the intestinal wall. Thus, there are hemangiomas arising from the vascular elements; fibromas, myomas, and lipomas, from the areolar tissue; myomas, from the muscular components, and adenomas, from the mucosa. The sites of preference are the rectum and distal segments of the colon. Schmieden and Westhues quoted the statistics of Thorbecke, who found the rectum involved in 54 of 70 cases in which polypoid tumors were found. Soper found the rectum involved in 95 per cent of 61 cases of polyposis of the colon, which included 50 cases studied by Doering, 2 of his own, and 8 others from the literature. Hemangiomas, fibromas, myomas, and lipomas do not exhibit this preference for the distal colonic segments. Dewis, reviewing 219 cases of various forms of benign intestinal tumors, found them to occur almost as commonly in the small intestine as in the colon. On the other hand, 89 per cent of the adenomas, which type constituted 58 per cent of the entire series, were situated in the rectum and colon. It is thus obvious that "polyps" and "papillomas," by which terms commonly are meant the adenoma-

* Read before the Chicago Roentgen Society, Chicago, Illinois, March 11, 1931.

tous growths arising from the mucosa, either as genuine neoplasms or as results of hypertrophic or hyperplastic change, are the most frequently found of all histologic types to be encountered. The tendency to regard all of these lesions as benign is justifiable only if they are not adenomas. The others tend permanently to be benign, but many adenomas exhibit microscopic evidence of malignancy without the slightest macroscopic evidence of such change.

The term "polyposis" might be applied in any case in which several polypoid lesions are found, but its meaning is usually limited to include only those in which the distribution of these growths is relatively abundant. In the intestinal tract these multiple lesions are almost without exception found to be adenomas. Bargen and Comfort classified multiple polyposis from the standpoint of origin and distribution of the polyps. Their first group included cases "traceable to definite, pre-existing inflammatory disease, such as chronic ulcerative colitis." The polyps are usually rounded, bud-like mucosal excrescences, distributed regularly over the involved intestinal segments, and may assume all the physical features of true sessile or pedunculated growths. Bargen and Comfort stated that in 10 per cent of all cases of chronic ulcerative colitis intestinal polyps eventually develop, and that of every 5 cases of polyposis observed at The Mayo Clinic, 4 have been on the basis of chronic ulcerative colitis. This represents the incidence ratio of this first group to the following groups taken together. The second group was composed of those cases in which the mucosa of the colon, in whole or in part, has undergone relatively diffuse adenomatous hyperplasia. Most of the polyps, perhaps, are genuine neoplasms, although Saint pointed out that in many regions there was nothing more than simple glandular hyperplasia. Distribution is diffuse, the mucosal surface is studded with myriads of bud-like processes and clusters, often to such an extent that the intestinal lining seems to have been changed into a villous mass of adenomatous tissue having the gross texture of a coarse sponge. There is no associated evidence of antecedent or concomitant inflammation or other disease. The third group included those cases in which the polypoid tumors are plural but not numerous, and are found in any part of the colon, but of which the sites of predilection are the distal segments.

From the viewpoint of roentgenologic diagnosis, the significant characteristics of these lesions are their intraluminal situation and their prevailing failure to produce a roentgenologically demonstrable deformity. In a previous paper I called attention to the difficulty of consistently demonstrating, roentgenologically, this type of lesion in the colon, but it must not be understood that these lesions have, in all instances, eluded roentgenologic detection. The roentgenologic-diagnostic principles applying to the recognition of polypoid lesions in the colon are identical with those applied to the detection of the same type of lesion in the stomach. Moore,[30,31] in a succession of papers, dealt with these principles. He stressed the necessity of approximation of the gastric walls by manual pressure to bring out clearly the smooth, sharp, and evenly rounded or ovoid contours of the characteristic filling defect. He also directed attention to the fact that these tumors have no tendency to produce a change in the outline of the stomach itself, that the gastric musculature is unaffected, that the wall remains pliant, and that there is seldom an associated palpable mass. Kirklin reasoned along the same lines in determining the presence of papillomas and polypoid lesions in the dye-filled gall-bladder. Application of these principles to investigation of the colon has made it possible, on occasion, to recognize the presence of a polypoid tumor or polyposis. The evidence, however, has almost without exception been roentgenoscopic. Roentgenography has been successful only when conditions were favorable for approximation of the walls of the barium-filled bowel by compression (Fig. 1). The lesions de-

tected have uniformly been large or very numerous. Lesions 1 cm. or less in diameter usually will elude detection even with the most careful roentgenoscopy; at least, it is extremely difficult roentgenologically to establish the presence of lesions of such small dimensions.

I do not think that the opaque enema has produced as reliable and accurate results as the opaque meal has yielded in the diagnosis of polypoid lesions in the stomach. Several factors are responsible for this. The mere act of filling the rectum and sigmoid constitutes a stimulus for evacuation of these viscera. Consequently the patient is apprehensive, he finds it difficult to relax his abdominal musculature, and thus satisfactory palpation is precluded. The sigmoid and rectum, which are the sites of predilection of polypoid lesions, are not accessible to palpation on account of their situation deep in the pelvis, and the complexity of the arrangement of the coils hinders adequate roentgenologic exposure. Fecal remnants, gas, and fluid in the colon, like remnants of food and secretion in the stomach, are notorious for their ability to simulate the type of lesions under consideration; and the difficulty of securing an adequately prepared colon is appreciated fully only by the patient and by those who have collaborated consistently to achieve complete removal of all foreign material from the lumen of the colon. I am thoroughly convinced that the full diagnostic benefits of the roentgenologic procedure cannot be had in the presence of foreign material of any nature in the colon.

Perhaps the failure of the prevailing roentgenologic method to disclose these lesions with sufficient precision may be held accountable, in part at least, for the poverty of roentgenologic literature on this subject. Müller was the first to deal with polyposis of the colon in a case report, with which he presented a roentgenogram exhibiting the characteristic multiple gross filling defects distributed throughout the colon. Carman and Miller produced two roentgenograms of the same case to illustrate the condition. In one of these, only the rectum and distal portion of the sigmoid are filled with opaque material, and there is nothing characteristic of polyposis

Fig. 1. Central filling defect in the sigmoid caused by polypoid tumor large enough to fill the lumen.

to be seen; in the second, however, there is a completely filled colon, with irregular mottling throughout, especially in those segments proximal to the hepatic flexure. Eickenbusch presented roentgenograms of a case of generalized polyposis associated with chronic ulcerative colitis. Chapman reported a case of colonic polyposis also in association with a chronic ulcerative process in the colon. His roentgenograms did not show the polyps clearly: observations six and twenty-four hours after the barium meal cannot be expected to produce reliable data in this disease, and Chapman's opaque enema did not fill the colon beyond the middle of the descending portion, due probably to inadequate preparation. Anderson and Marxer reported two cases of multiple polyposis of the colon, both of which were in association with chronic ulcerative colitis. The roentgenograms they

exhibited were excellent, showing both the characteristic mottling produced by the multiple central filling defects, and the familiar roentgenologic signs of the primary disease.

The roentgenologic literature available to me contains but two cases which might be included in the group of cases of generalized colonic polyposis unassociated with chronic ulcerative colonic disease. Müller's case is one; Fischer's case[16] is the other. Elsewhere I have not seen diagnostic roentgenograms, although writers considering the disease from clinical, pathologic, or surgical aspects have included such cases in their reports. I look on this as a failure of roentgenologic methods strikingly to depict the disease.

If roentgenologic methods in general use have proved inadequate on account of their failure, with opaque materials to afford visualization of the intraluminal appearance of the colon, it seems logical to inquire into the value of materials on the opposite end of the scale of transmissibility of rays, the gases, for use as contrast substances. In the early years of roentgenology they were used for this purpose. Pfahler proposed the idea in 1907. Cole and Einhorn, however, were apparently the first to submit experience with the use of gas in the investigation of pathologic change in the colon. Although they did not think that gases would ever replace metallic salts as contrast substances, they felt that gases might be applied, when, for some reason, the use of the opaque salts might be inadvisable or contraindicated. Air and carbon dioxide were the gases chiefly recommended. Krauss believed oxygen to be superior to other gases for the purpose, because, he said, it is easier to apply, affords better contrast, and is more comfortable for the patient. These reasons do not seem to be theoretically adequate. Krauss' illustrations depicted the colonic contours more vividly than those of Cole and Einhorn, and he felt that the method would become universally applied. Burkhardt applied the method of Krauss, intimating that he used it to demonstrate abnormal narrowing and widening of the colon, as well as the presence of foreign bodies and polypoid tumors.

Insufflation of the colon with air and other gases obtained considerable favor for a time with another group of investigators who used it in roentgenologic demonstration of the liver, gall-bladder, spleen, and kidneys, and to disclose the intra-abdominal relationships of extra-colonic tumors by the enhancement of contrast and relief afforded by the high radiability of the insufflated intestine compared with that of the less radiable adjacent masses of tissue. Rosenfeld, according to Fischer, was the first to apply the method for this purpose. Meyer-Betz was particularly interested in depicting the characteristics of the liver, especially its lower border, and his illustrations are worthy of special comment. Löffler dealt with the demonstration of the liver, spleen and gall-bladder; Henszelman was very enthusiastic over his success in demonstrating variations in the contours of the spleen; Philips insufflated the colon with air to aid in roentgenologic demonstration of a large hypernephroma. In a sense, insufflation of the colon for this purpose might be considered similar to the use with which it was identified in the era before the use of roentgen rays when the colon was filled with air through the anus to assist in determination of the size, shape, and intra-abdominal relationships of enlarged organs and tumors, largely by changes demonstrable by abdominal percussion (Ziemssen, Runeberg). Rost, Dryer and others used the same procedure largely to elicit differential subjective evidence of disease in the right lower abdominal quadrant, such as appendicitis, mobile cecum, and pericolitis.

Schwarz, in his monograph on the clinical roentgenologic diagnosis of the colon, briefly considered the topic of colonic insufflation, and dismissed the procedure as possessing little practical diagnostic value. This opinion has apparently become universally adopted, for the method has found

few defenders other than those mentioned, and at the present time it has been almost entirely abandoned as a roentgenologic diagnostic procedure.

Krause, in 1910, recommended barium sulphate as a highly satisfactory contrast material, and at the present time this substance has almost entirely replaced the salts of bismuth. Laurell used a combined method. However, there has been no accepted innovation in roentgenologic methods until the work of Fischer became known. After a period of experimentation with various contrast combinations, including air, he hit on the idea of a "combined method," which utilized two differential mediums at opposite poles of the contrast scale, combining the advantages of each and avoiding their individual disadvantages. In his presentation of the work, Fischer[13,14] undertook a comprehensive theoretic and practical consideration of all methods heretofore applied to the roentgenologic investigation of the colon, as well as of the new method which he proposed.

Briefly, the technique of this new method is as follows: After the administration of a laxative, rigorous enough to insure complete removal of all foreign material from the lumen of the colon, assisted if necessary by enemas, the patient is given the opaque clysma. This consists of 300 gm. of barium sulphate, 300 gm. of bolus alba, and water sufficient to make 1,000 c.c. of suspension. The enema is administered under roentgenoscopic control, assisted by manipulation of the colon through the abdominal wall. When the colon has been filled with the opaque material, a roentgenogram is made. Fischer stated that in most cases insufflation may proceed at once, and that overdistention of the colon need not be feared. Sometimes, however, it is advantageous to allow the patient to evacuate the enema "partially" or "as completely as possible."

The apparatus used is simple. In addition to the necessary equipment for administration of an enema by the gravity method, only a hand blower, consisting of an enema tip attached to a rubber balloon and bulb, is needed. Insufflation is instituted with the patient lying on the right side, but he may be rotated to other positions as the air continues to fill the colon. The quantity of air injected is variable, depending on such obvious factors as the size of the colon and the extent to which the examiner wishes to distend it. Fischer found the proportion of four parts by volume of air and one part of contrast fluid to be ideal. Roentgenograms, preferably with the use of the grid diaphragm, are made immediately after the insufflation has been completed, in whatever position of the patient serves best to demonstrate those colonic segments on which interest is focused.

The picture of the colon thus obtained is complicated, and Fischer entered on a thorough analysis of the various features of the collections of gas, fluid levels, "fluid mirrors," and mural contours which is not easy to understand and evaluate. Results of the methods as applied to a group of cases representative of the various types of pathologic processes encountered in the colon were also analyzed and illustrated.

The conception of a roentgenologic technique permitting vizualization of the contours of the intestine, without obscuring or destroying intraluminal relief, has a strong appeal. In my experience, the method of Fischer, unmodified, does not approach sufficiently near to this ideal. Studies on the inner relief of the alimentary canal with which the names of Forssell, Knothe, and Berg are identified, offer clues to the further possibilities of the combined technique. If it is possible to apply to the intraluminal mucosal surface of the intestine a coat of opaque material dense enough to preserve the contours of the lumen of the colon, yet sufficiently radiable to permit accurate estimation of intraluminal relief, the procedure, theoretically, at least, should offer an exposition of the interior aspects of the lumen comparable to direct vizualization of those surfaces. It will be found, however, that the simple application of this concept is rendered complex,

Fig. 2. Combined method. Polypoid tumor in the sigmoid (2×3×2.5 cm.). Similar tumor, although smaller, in the upper part of the descending colon. The circular shadows seen especially in the hepatic flexure were diverticula; stereoscopic examination showed them to be definite outpouchings of the colonic wall.

principally on account of interference between the relief patterns of the opposing intestinal walls, and of intertwining and overlying coils of colon seen especially in the most proximal and most distal segments. The application of stereoroentgenography is immediately suggested as a possible solution of this difficulty. Moreover, it serves, simultaneously, as a valuable aid in the determination of the precise relationships of extracolonic abdominal shadows which might simulate intrinsic lesions (Fig. 2).

Comment has already been made on the failure of ordinary roentgenologic methods precisely and consistently to demonstrate the presence of polypoid lesions, whether single or multiple. It is known that these lesions can be the basis of a clinical picture of varied severity, at times attended with intractable diarrhea and intestinal bleeding, and sometimes providing the immediate cause for intestinal intussusception. But full realization of the importance of these lesions will come with consideration of the work of Schmieden[38] and of Schmieden and Westhues[39], Doering, FitzGibbon and Rankin, and others, whose histologic studies have proved that many of these lesions are in fact carcinomas, or that they have a tendency to develop malignant characteristics, and which indicate that at least some well-defined colonic malignant growths have their beginnings in these intestinal adenomas. This conception introduces the indication for surgical removal of the affected segments, and it becomes imperative not merely to establish the presence of individual polyps, which function rectosigmoidoscopy performs in the most distal segments of the colon, but to determine the occurrence and extent of similar growths in the more proximal portions.

I have applied the "combined method" of Fischer, modified along the lines indi-

Fig. 3. A convenient apparatus for colonic insufflation. The enema tip is the same instrument used in the administration of the opaque enema.

cated, to the demonstration of polyps and polyposis of the colon. Diagnostic results have been gratifying. In the application of this technique it is essential that all residues and fecal remnants be entirely removed, and that the walls of the colon be collapsed. On the day before the examination, the evening meal is withheld, and 2 ounces (60 c.c.) of castor oil is adminstered. On the following morning, the distal part of the colon and rectum are cleansed by one or two plain, low enemas. Saline purgatives, and cathartics which depend on the property of activating the bowel by irritation, are to be avoided. The patient then presents himself at the roentgenologic laboratory, and the opaque enema is administered under roentgenoscopic control. The opaque material in the enema should be minutely divided, uniformly suspended, and the suspension should be well sustained. Several commercial preparations of the opaque salt are available which are satisfactory, or a suspending agent, such as gum acacia, may be added to the enema when it is prepared in the laboratory. The consistence of the enema should approximate that of heavy cream.

Fig. 5. Roentgenogram after administration of opaque enema (same case as Figure 4). The appearance of the entire colon is normal.

Fig. 4. Combined method. Large polypoid mass in the proximal part of the sigmoid. Pedunculated polypoid mass in the left part of the transverse colon. Stereoscopic examination revealed many similar though much smaller polypi especially in the proximal colon.

Roentgenoscopic and roentgenographic study should be completed with dispatch because the opaque salt sometimes goes out of suspension rapidly, due perhaps to the dehydrating function of the colon. It is not always easy to obtain ideal distribution and concentration of opaque material on the mucosal surface of the colon. No more than a uniform thin coat is desirable. The patient is told to evacuate the enema as completely as possible, and it will usually be found that a sufficient amount of the material remains in the lumen after evacuation. If large collections of the material are still seen after the attempt at evacuation, the rectum can be insufflated with a volume of air sufficient to induce a desire for defecation, whereupon the patient usually will return with as near the ideal distribution and concentration of opaque material as is pos-

Fig. 6. Specimen of the colon (same case as Figures 4 and 5) removed at operation. The dark mass is the large polyp of the transverse colon seen roentgenographically in Figure 4. There are multiple smaller polypoid tumors distributed throughout the specimen. Resection of the sigmoid and rectum will be done as a final stage of total colectomy at a later date.

sible in his case. The hand blower used for insufflation is herewith illustrated (Fig. 3). The colon is inflated, under roentgenoscopic control, and care is exercised not to overdistend any of the segments. The procedure is facilitated by frequent rotation of the patient on the roentgenoscopic table, and by manipulation of the bowel through the abdominal wall. Insufflation carried out in this way has not been in any way more distressing to the patient in any case than administration of the opaque enema. The fluoroscopic image of the air-filled colon lacks sufficient detail to be of diagnostic value. The enema tip is removed from the rectum as soon as the cecum has been moderately distended, and stereoroentgenograms are made with the patient lying on the abdomen. The grid diaphragm is of distinct advantage in educing the fine detail requisite for precise demonstration of the character of the lesions.

I have previously reported briefly on first experiences with this technique.[44] Polypoid tumors which occur singly or relatively sparsely are visualized as rounded, soft projections into the intestinal lumen (Figs. 4, 5, and 6). Their contours are outlined vividly in the air-distended bowel, and it is possible, when sufficient care has been exercised in carrying out the technique, to determine the nature of the surface contours of the growths (Figs. 7 and 8). Properly applied, the method affords an estimate of the integrity of the interior of the colon attainable by no other method except direct visualization by the proctosigmoidoscope, or surgical or postmortem exploration. An especially vivid picture is obtained in the presence of generalized colonic polyposis (Figs. 9 and 10), in which the entire mucosa, or a relatively large portion of it, has undergone adenomatous hyperplasia. Settling into the deep crevices between the masses of polypoid tissue, the opaque material forms a coarse network of shadows that is pathognomonic of the condition. When generalized polyposis is secondary

Fig. 7. Large polypoid mass in the cecum. Stereoscopic examination revealed small irregular projections from the surface of the tumor. At operation, a polypoid tumor 13×9×1.5 cm. was removed. Microscopic examination showed this tumor to be a carcinoma, graded 2.

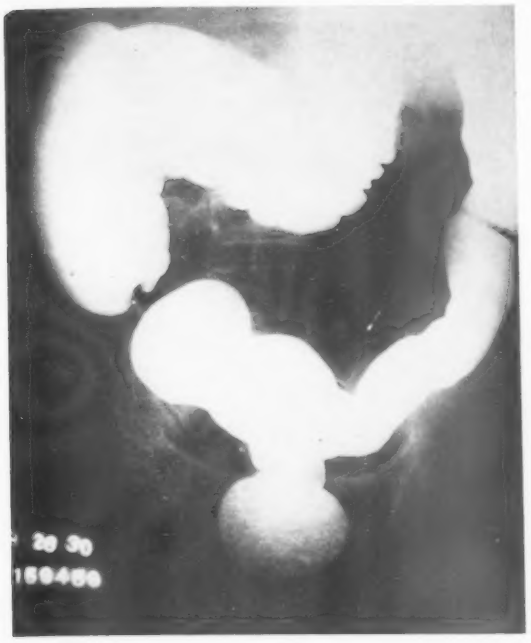

Fig. 8. Roentgenogram of same growth as Figure 7 made after administration of opaque enema.

Fig. 9. Combined method. Generalized polyposis. Diffuse involvement of the entire colon, with small polypoid intraluminal masses. The lacy network of shadows is pathognomonic of the condition.

to pre-existing ulcerative or inflammatory disease, the changes produced by the primary process predominate in the roentgenologic picture. The affected segments are narrowed, foreshortened, and hyperirritable; haustral markings are absent, and the contours are smooth. Usually the polyps seen in association with a chronic ulcerative process are smaller, more irregularly distributed, less prone to be well-rounded and pedunculated, and more tag-like in appear-

Fig. 10. Roentgenogram made immediately after administration of opaque enema (same case as Figure 9). Attention is called to the normal contours of the colon, except for a short segment of the descending colon near the splenic flexure which suggests the condition found.

ance than those found in cases in which a pre-existing primary disease cannot be established. Cases of polyposis, then, in their roentgenologic aspects can be satisfactorily placed in one of the divisions made by Bargen and Comfort. If another group is made to accommodate the single polypoid lesion, the classification is satisfactorily inclusive.

This combined method is not recommended at the present time as a routine. Compared with the barium enema it is

FIG. 11. Roentgenogram made after evacuation of opaque enema. The relief picture is suggestive of polyposis. This illustrates an almost ideal distribution of opaque material in the colon after evacuation of the enema for best results with the combined method.

FIG. 12. Combined method. Diffuse colonic polyposis (same case as Figure 11).

cumbersome, relatively expensive, and offers too little additional information in those diseases which produce luminal deformity unless specifically indicated. In an overwhelming majority of cases in which polyps are found in the rectum and sigmoid, similar lesions have been found in the more proximal colonic segments (77 per cent according to Thorbecke; 95 per cent according to Soper). Therefore the majority of cases will be referred for roentgenologic examination by the proctoscopist. Patients who have very small polypoid mucosal tags, less than 1 cm. in their longest dimension, will thus present themselves for examination. I have not been able, even with the combined method, to establish with certainty the presence of polyps much less than 1 cm. in diameter. Cases in which there is clinical evidence of intestinal bleeding, or in which intussusception is suspected but routine methods have failed to explain the symptoms, have been subjected to this procedure at The Mayo Clinic. Roentgenologists whose practice it is to make a roentgenographic or roentgenoscopic examination of the colon after evacuation of the opaque enema, may find reason to apply the combined technique to explain obscure features disclosed by this useful procedure (Figs. 11 and 12). I have found the method valuable in roentgenologic investigation of those rarer conditions in which the colon presents some anomaly of development, such as failure of descent and rotation, and in cases of marked redundancy in which roentgenoscopic examination has proved indeterminate on account of the difficulty of manually disengaging the coils or the difficulty of simplifying the complex shadow of overlying loops by rotation and separation (Figs. 13 and 14). The method may be used on occasion for roentgenographic demonstration of a colonic lesion which may have been clearly and adequately visualized roentgenoscopically, but which is obstinately obscured in the roentgenogram by overlying loops filled with dense, opaque material. Gershon-Cohen

Fig. 13. Complete failure of rotation of the colon. Roentgenogram made after administration of opaque enema. The individual coils are obscured by the dense mass of opaque material with which they are filled.

Fig. 14. Combined method. Stereoscopic examination makes it possible to identify the course and integrity of the entire colonic lumen (same case as Figure 13).

and Fischer[12] applied the latter's unmodified technique in the roentgenologic investigation of tuberculous lesions of the colon with apparent great satisfaction.

Except in those cases in which patients have been referred especially for determination of the presence of polypoid lesions, my practice has been to use the opaque enema first, and to apply the combined method whenever the data yielded by the opaque enema were insufficiently precise to make it possible to come to a decision about the nature of the disease present. I have applied the combined method, also, in the presence of disease of the colon other than polypoid lesions and polyposis. Because of its novelty, however, I hesitate to render an estimate of the value of the combined method in the differential diagnosis of deforming diseases of the colon. It seems probable that with accumulation of experience and with refinement in technique, with which a more widespread application inevitably will be accompanied, the combined method will make valuable contributions toward increased accuracy in the roentgenologic differential diagnosis of all types of diseases of the colon.

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FURTHER STUDIES IN THE APPLICATION OF INTRAVENOUS CHOLECYSTOGRAPHY AND LIVER FUNCTION DETERMINATION AS EMPLOYED IN OFFICE PRACTICE*

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OUR reason for again presenting this subject for your consideration is, primarily, to stimulate and encourage a more generalized employment of the intravenous method of cholecystography and also to discuss the complications so far encountered, and the possibilities of their elimination. Two years have elapsed since we began the office employment of intravenous cholecystography and while we have had annoying reactions recently, none have been serious, and we have no reason to be other than optimistic.

There are three complications which attend the employment of this method. The commonest and least serious is urticaria, which can be promptly controlled by 5 to 10 minims of adrenalin chloride hypodermically; second, endophlebitis obliterans; third, "sore arm." Unquestionably, the most annoying complication is endophlebitis at the site of injection, and while we had experienced only one in our first 96 cases, as reported last year, we have unfortunately encountered it more frequently during the past few months. We have endeavored to ascertain the exact cause of this complication, but up to the present time have not been able to reach a final conclusion. In any method attended by complications, it is only fair to discuss openly and freely all phases of the subject in the hope that valuable information may be elicited. Up to the present time only two conditions contraindicate the employment of intravenous cholecystography, namely, cardiac decompensation and threatened uremia.

The exponents of intravenous cholecystography have unanimously agreed that the annoying complications are "sore arms" and so-called venous thromboses. These two conditions must not be confused, although many have looked upon them as a single entity. "Sore arm" is a cellulitis due to the action of the dye in the subcutaneous tissues and is the fault of the person making the injection. While the isomeric salt, phenoltetraiodophthalein (iso-iodeikon), is not nearly so irritating to the tissues as tetraiodophenolphthalein (iodeikon), it nevertheless produces a severe inflammation when extravasation occurs. While sore arms do occur and are an annoying complication, they are purely accidental and avoidable, and should play no rôle in preventing the adoption of this method.

So-called venous thrombosis is, in reality, not a thrombosis, but an inflammation of the intima resulting in obliteration of the lumen of the vein, otherwise known as endophlebitis obliterans, similar to that which occurs in varicose veins following surgical treatment by injection with any strongly alkaline or acid solution. As in any other inflammation, there is a formation of granulation tissue with final fibrosis so that the lumen becomes obliterated, the vein remaining as a fibrous cord. That endophlebitis obliterans does not occur more frequently may be due to the fact that veins vary somewhat in their collapsibility, the obliteration being dependent upon approximation of the inflamed surfaces and therefore directly proportional to the collapsibility of the vein. Digital pressure upon the vein during or immediately following the injection is likewise conducive to intimal adherence with resultant obliteration of the venous lumen.

It is well established that any alkaline solution, whose pH is fairly high, will pro-

* Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23–26, 1930.

duce intimal inflammation; it is therefore obvious that the present dye, whose pH is well above 8.0, is not ideal for intravenous administration as the average pH of blood is 7.35. In a number of our cases, after completion of the injection, a vein in the opposite arm was injected with normal salt solution from the same burette in order to see whether the vein receiving the salt was as susceptible to obliteration as the vein receiving the dye and, as we supposed, obliteration never occurred in the vein receiving the salt, but did occur in some instances in the vein receiving the dye. The fact that the vein is thoroughly lavaged with salt solution before and after the introduction of the dye does not prevent the development of endophlebitis, but we do believe it lessens its severity.

Sterilizing the dye by means of a boiling water bath for twenty minutes has a tendency to form a precipitate, the character of which is not definitely known, but which was thought might be a factor in the production of endophlebitis. With this idea in view we prepared our solutions in a different manner for a number of cases. The distilled water, funnel, filter paper and flask were sterilized by autoclaving for twenty minutes at 20 pounds pressure. The dye, in hermetically sealed ampules, was then dissolved in 100 c.c. of sterilized, distilled water, cooled to body temperature, and filtered through the sterilized paper and funnel into a sterile flask. While the preparation of dye in this manner apparently eliminated the precipitate, it did not seem to minimize the number of cases of endophlebitis. We now dissolve the dye in 100 c.c. of freshly distilled water, filter the solution and boil in a water bath for twenty minutes, as previously described.

The dye and normal salt solution are contained in separate burettes and are introduced by gravity. A venepuncture is made with a No. 19 needle into one of the veins of the antecubital fossa, previously cleansed with iodine and alcohol. After withdrawal of blood into the syringe, a small amount of salt solution is introduced in order to be sure that no extravasation or leakage has occurred. This is followed by a small amount of dye and we attempt to maintain a three to one ratio of salt to dye throughout the injection. After all the dye has been introduced, at least 50 c. c. of normal saline is allowed to flow in, in order to thoroughly cleanse the vein of any dye at the site of injection and prevent any leakage on withdrawal of the needle.

In a search for the cause of endophlebitis obliterans in this test an interesting point has been noted in our series since our last publications[1,2] and it is our opinion that it should be discussed. We mention this fact because to us it is very striking. In our first 96 cases we encountered only one inflammatory reaction, this occurring in a patient injected on September 8, 1929, but since then it has occurred more frequently. Knowing that a distinct and definite change had taken place every possible clue was investigated. In examining our files we found that the price of iso-iodeikon was reduced 50 per cent on August 30, 1929, and our first endophlebitis occured in a patient injected with the cheaper dye. While we feel that the strong alkalinity of the dye is responsible for this complication, we believe that the dye has changed in some manner with the reduction in its cost.

Liver Function Test Employing the Young-Elvers Universal Colorimeter. Attention has previously been called by Graham and his coworkers and by us to the fact that phenoltetraiodophthalein stains the blood serum. This method of estimating the liver function is as follows. One-half hour after the completion of the injection of dye, 15 c.c. of blood is withdrawn from a vein in the antecubital fossa of the other arm. This blood is placed in a test tube and kept in a cool place, although not necessarily in an ice box. The following morning 1 c.c. of the supernatant serum is diluted with 3 c.c.

[1] Waters, C. A., and King, J. H. Intravenous method of cholecystography and liver function test as employed in office practice. AM. J. ROENTGENOL. & RAD. THERAPY, 1930, *23*, 34-43.

[2] Miller S. R., and Waters, C. A. Intravenous cholecystography and liver function determination; clinical and roentgenological value. *South. M. J.*, 1930, *23*, 1079-1088.

water or normal salt solution. To one glass cell is added a few drops of alkali, preferably 5 per cent sodium hydroxide, in order to bring out the color of the dye. In the other cell is placed the serum and the water without the alkali, for comparison. The readings may be made in daylight or artificial light. On the front of this instrument there is a single lens which transmits the colors of the unknown serum and the colors of the standard which is furnished with the instrument for this particular dye, so that the two colors can be seen through one aperture. A retention of about 12 per cent of the dye in the blood serum one-half hour after the injection or about 4 per cent one hour after the injection is considered within normal limits. The greatest retention in our series has been found in patients with various forms of acute cholangitis and hepatitis, and in some cases of acute cholecystitis. The amount of retention of the dye in the blood serum may reach 80 per cent. The highest in our series was one of 80 per cent in a patient fifty-nine years of age presenting cholecystographic evidence of a normal gall-bladder and on whom no operation was performed. The next highest was a recent case of 70 per cent in a woman aged forty-five with normal cholecystographic response and no clinical manifestations of hepatobiliary disease. Another case, with 40 per cent retention, was operated on with no postoperative complications and made an uneventful recovery. Graham and his coworkers have pointed out that patients suffering from hepatobiliary tract diseases and showing high retention of dye in the blood serum are usually very poor operative risks, in whom the outcome is not infrequently fatal. The value of this liver function determination is questionable at the present time owing to the fact that the liver has so many diversified functions and so few reports have been published concerning its efficacy. Unquestionably, a high retention is a distinct warning against operative intervention and should not be unheeded, except in most extreme cases.

The Clinical Evaluation of the Intravenous Versus the Oral Method in the Non-Operative Group. In the preface of Graham and his associates' book, "Diseases of the Gall-Bladder and Bile Ducts," is the rather startling statement that between 20 and 25 per cent of all adults harbor gallstones and possibly an equal number suffer from cholecystitis without stones, or, in other words, nearly one-half of the adult population is subject to disease of the biliary and hepatic systems. It is also of great significance to note that not only Graham, but other authors are increasingly active in stressing the point that the so-called classical symptoms of these conditions are by no means what they are depicted in most textbooks, that many instances of these diseases are unaccompanied by any particularly severe clinical manifestations and unquestionably more victims are inadequately treated because so many of them fall into the group of so-called functional gastrointestinal neuroses or so-called "nervous indigestion" or "dyspepsia." On first sight, it would seem that it ought to be relatively easy to diagnose acute cholecystitis or acute conditions in the right upper abdomen, but it might be worth while at this point to briefly remind both the surgeon and the internist that the differential diagnosis of conditions in the right upper abdomen is by no means as simple as we are prone to believe. The same general statement can be made with reference to the more chronic type of diseases in the right upper abdomen and particularly to those cases which do not present, in any respect, the clinical picture of so-called biliary colic. We have not yet reached a stage where, with any degree of certainty, we can separate the purely functional group, whose main complaint is indigestion, from those in whom this symptom, in one of its many various manifestations, is the evidence of underlying hepatobiliary tract disease, either already well established or in its incipiency. If the statements referred to above are true and 40 per cent or more of the adult population is suffering from cholecystitis and associated diseases, then it is at once apparent that herein lies

a tremendous field for increasing diagnostic certainty, and cholecystography, successfully applied to cases manifesting these early signs of disease, is probably our most important agent in detecting these cases and protecting a large percentage of them from drifting over to a more serious chronic condition.

There still exists, in the minds of many, misconceptions as to the nature of this test. Graham has pointed out that cholecystography is primarily a study of both liver and, particularly, gall-bladder function rather than a test of liver and gall-bladder disease. If a shadow of the gall-bladder is to be secured it is necessary (1) that the dye shall have access to the liver; (2) that the liver shall secrete the dye into the bile; (3) that the bile shall have access to the gall-bladder through a patent cystic duct; (4) that the gall-bladder mucosa be capable of concentrating the dye sufficiently to cast a shadow, and (5), that the gall-bladder under certain conditions be capable of emptying itself in a so-called normal manner. If such are the problems to be tested, it must at once become obvious that certain other things are imperative for a proper interpretation of the function test itself; the one and most important is to be certain that the dye in question has reached the liver in proper amount and, having done so, that it is secreted in sufficient amount into the bile itself.

Two schools now exist among roentgenologists concerning cholecystography, the one insisting on the entire adequacy of the oral method, while the other maintains that it is inefficient as compared with the intravenous route. The proponents of the oral method think the dye is far easier to administer, that it avoids any possibility of introducing infection into the blood stream as well as the avoidance of any likelihood of endophlebitis obliterans and sore arms. They also maintain that the oral method of administration is not apt to be followed by unpleasant reactions, but there is no uniformity in the statements as to how frequently nausea, vomiting and diarrhea occur when the dye is given by mouth. In our experience, these instances have been rather high. The advocates of the oral method, however, are forced to admit that satisfactory cholecystograms are quite frequently not obtained, with the result that the test has to be repeated, often several times, and even then with inconclusive findings. These repeated non-fillings or faint visualizations in both normal and pathological cases are unquestionably the greatest disadvantage of the oral method, and this is probably the resultant of two factors: first, the alteration in the acidity of the stomach and small intestine whereby the dye is altered before its absorption into the portal circulation, and second, absorption of the dye by the gastric and intestinal contents in such small amount as to prevent an adequate quantity from entering the portal circulation. In other words, the absorption factor by the oral method is an uncertain one, and, as a result, non-visualization of the gall-bladder may mean either that gall-bladder function is impaired or, equally important, that an insufficient amount of the dye has reached the liver. This disadvantage is entirely overcome by the intravenous administration of the dye, for by this method it is known that a definite quantity enters the circulation, and in an amount which has been found to be sufficient to produce satisfactory cholecystograms. Those who discountenance this method of administering the dye do so mainly on grounds that the method is rather technical, time-consuming, and hence possibly impractical, and particularly stress the danger of untoward reactions. These also contend that fewer disagreeable reactions are encountered by the oral as contrasted with the intravenous method, although this is not borne out either in reports in the literature or by our own experience. It is our purpose in presenting this report to add our experiences to those of others in favor of the intravenous method and to show that it is essentially devoid of dangerous reactions, that it is not time-consuming nor complicated,

that the resultant cholecystograms offer evidence which is far more dependable than that obtained by the oral method, and finally, to emphasize the fact that the method can be easily and safely carried out in office practice.

The diagnostic accuracy of the oral method in the operative group of cases can be easily understood when one considers the fact that this group usually presents outspoken clinical indications for surgical intervention. The cholecystographic evidence ordinarily adduced as a basis for a positive diagnosis is here likely to be correct. But we seriously question a similar accuracy in that large group of patients who, at least temporarily, escape the operating room. In our two years' experience with intravenous cholecystography, at least 25 per cent of those cases who had previously been grouped as normal by the oral method were, on the contrary, found pathological by the intravenous method antecedent to confirmatory operation, and at least another 25 per cent of those previously grouped by the oral method as inconclusive or pathological presented normal findings on employment of intravenous technique. If the proponents of oral cholecystography could only know the tremendous number of their non-operative cases who subsequently reach clinics in which the use of the intravenous method is productive of entirely different and more definite cholecystographic evidence, we feel certain that they would consider the employment of this method. In conclusion, we wish to point out that the clinician today is particularly anxious to obtain correct diagnostic information in that large group of patients with vague right upper quadrant symptoms, that the intravenous method is an effective means of differentiating the purely functional from those with actual hepatobiliary tract disease, either incipient or chronic, and, finally, that any practicable method which better enables a diagnosis to be made both early and accurately should certainly be the method of choice.*

* For discussion see page 615.

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NECESSITY FOR ACCURATE TECHNIQUE IN ORAL CHOLECYSTOGRAPHY

ERRORS ATTRIBUTABLE TO TECHNICAL LAPSES*

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Of the two methods of cholecystography, the oral method of administering the opaque dye is far more extensively employed. Yet it is widely assumed, and many adherents of this procedure have been disposed to grant without argument, that it is considerably less accurate than the intravenous method. I am convinced, however, that this assumption has been derived largely from the experimental period of cholecystography, when methods in which the dye was given by mouth were diverse and highly imperfect; that statistical comparison of the two methods often has been made under conditions which were not validly comparable, and that if a rational and punctilious technique is employed, the diagnostic results following oral administration of the dye are fully as reliable as those obtained when it is given intravenously. Experience has furnished abundant proof that in giving the drug by mouth the following conditions should be met:

1. It should be administered in sufficient quantity and in freely absorbable form.

2. It should be so given that it will not tend to excite nausea, vomiting or annoying catharsis.

3. It should be taken into the stomach immediately after the ingestion of a full meal containing a minimal quantity of fats.

4. Fats should be withheld subsequently until the gall-bladder has had opportunity to fill with dye-laden bile and to concentrate it.

5. As a routine, roentgenograms should be made at not less than three properly spaced intervals.

6. A fatty meal between the final sets of roentgenograms is essential.

7. Other food or drink that might empty the gall-bladder prematurely should not be taken by the patient.

8. Purgatives and other medicaments that may affect the motility or absorbability of the bowel or the function of the gall-bladder are to be interdicted during the period of examination.

The routine procedure now satisfactorily employed at The Mayo Clinic represents an effort to fulfill these requirements, but attained its present form only after a long period of trial and error. As in many other roentgen laboratories, various cholecystographic mediums have been tested, but none has been found superior to the sodium salt of tetraiodophenolphthalein. It is dispensed to the patient in a uniform dose of 4 gm., freshly dissolved in 30 c.c. of distilled water. The patient is instructed to mix the solution with a glassful of grape juice, orange juice, or a carbonated mineral water, and to drink the mixture immediately after finishing the evening meal. When taken as directed, such a mixture is palatable to most persons, is readily absorbable by the bowel, and is seldom followed by nausea, vomiting or troublesome catharsis. In this connection, however, three points are to be stressed: the meal is required to be of substantial amount, reasonably free of fats, and followed at once by the cholecystographic compound.

It will be recalled that in the early days of cholecystography by this method, when the drug was given in capsules or pills on an empty stomach, when the stomach contained little food, or at a considerable in-

* Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23–26, 1930.

terval after the meal, the acid gastric juice combining with the outer layer of the drug formed a viscid envelope which prevented disintegration of the compound, and the mass traversed the bowel without breaking up. Further, under these conditions, in whatever form the drug was given, it frequently provoked vomiting or failed to be absorbed. For these reasons, I have for some time required the patient to take a fat-free meal of substantial amount and follow it immediately with the compound.

Many roentgenologists have been slow to learn that the meal with which the cholecystographic medium is taken must be fairly free of fats. It might be reasoned that a meal containing fats would empty the gall-bladder of its current contents and thus prepare it for subsequent filling with dye-impregnated bile. My own experience indicates, however, that the effect of the fat continues into the period when filling with bile and concentration of the dye should occur. Three years ago I purposely gave the compound in conjunction with a fatty meal to an extensive series of patients. At once the number of patients in which the shadow was absent or faint increased by approximately 25 per cent, thus warranting the diagnosis of cholecystic disease. But the positive diagnostic errors, as revealed by operation, rose in the same ratio. On excluding fat from the meal, the proportion of abnormal responses and likewise of positive errors immediately fell. Since then I have adhered to the fat-free meal, and I feel strongly that it is indispensable for reliable cholecystography.

It is thoroughly understood that fats must be withheld during the period of filling of the gall-bladder and concentration of the bile, and few errors are committed in this respect. Directing the patient to take fats between the final sets of films is also a routine measure. Its chief object, however, as I see it, is not to determine whether the gall-bladder is capable of emptying itself by contraction, nor to demonstrate the rate of evacuation. Any gall-bladder which fills with dye-laden bile is able to discharge it, and the rate of emptying, whether fast or slow, is not a safe criterion for diagnosis. But the interim fatty meal is highly useful, first, to exhibit to better advantage papillomas or stones, which are more readily visible in a small amount of opaque medium (Figs. 1, 2, 3 and 4), and second, to distinguish, by the fact

Fig. 1. Distended gall-bladder in which the dye is so densely concentrated that the gallstones seen in Figure 2 are not visible.

Fig. 2. Same case as that shown in Figure 1, showing multiple gallstones after the gall-bladder has contracted following a fatty meal.

Fig. 3. Cholecystogram while the gall-bladder was distended. The defect at the fundus of the gall-bladder demonstrable in Figure 4 is not shown.

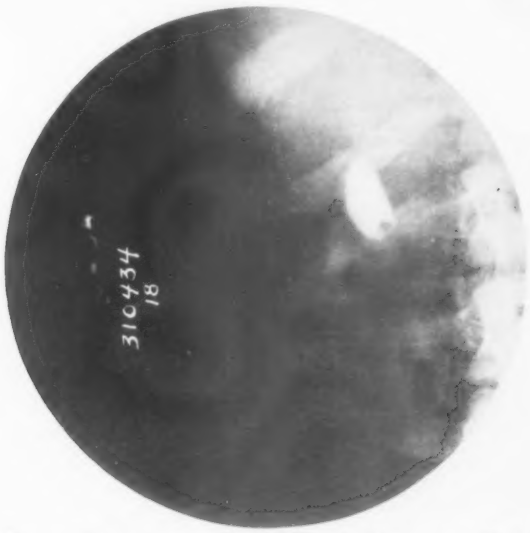

Fig. 4. Same case as that shown in Figure 3. Cholecystogram taken after a fatty meal. A small adenoma at the fundus of the gall-bladder is shown.

that it alters in size, a true cholecystographic shadow from a primary shadow cast by a diseased gall-bladder.

For obvious reasons, the patient should not take, during the period of examination, purgatives or any medicines which affect the digestive tract. I am also rather firmly of the opinion, although proof is lacking, that castor oil and perhaps other purgatives taken within twenty-four hours prior to the test may vitiate the results.

Painstaking roentgenographic technique is also requisite for efficient diagnosis, and this applies to all methods of cholecystography, whether the drug is given orally or intravenously. Before cholecystography was known, the necessity of an exacting technique to exhibit the gall-bladder was fully appreciated. Although cholecystography has made certain details superfluous, it has brought others instead, and unless they are executed with the same care

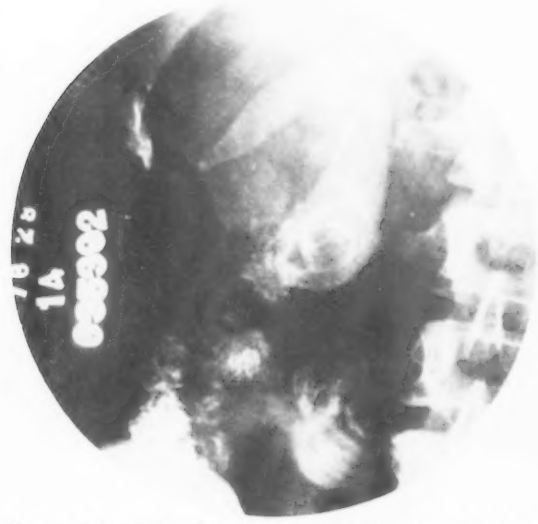

Fig. 5. Normally functioning gall-bladder with large stone.

Fig. 6. Movement is sufficient completely to blot out the large gallstone shown in Figure 5.

FIG. 7. Very small stones in a normally functioning gall-bladder, illustrating the type of stone shadows easily obscured by the slightest motion.

as of old the best diagnostic results will not be attained. It is well understood that prevention of movement is a prime consideration, for the slightest displacement of the gall-bladder during roentgenography may obliterate evidences of stones or papillomas (Figs. 5, 6 and 7). In our laboratory such movement has been minimized: (1) by employing a high milliamperage and a short time of exposure; (2) by immobilizing the patient with a broad canvas band drawn tightly over his back, and (3) by requiring him to exhale deeply and then cease breathing during the exposure. I consider arrest after expiration superior to the more common custom of having the patient hold his breath after deep inspiration, for by the latter method the intensity of his effort is likely to cause sudden involuntary movement. Occasionally in deep exhalation the gall-bladder ascends under the ribs and is obscured by their shadows, and in such instances the later sets of roentgenograms can be made after inspiration. Tenseness of the patient, which is largely responsible for unintentional movements, is lessened by placing him in an easy position on the table. He is not permitted to support his head on his chin, stretch his arms upward unduly, or cross his legs, but is required to lie with his cheek to the pillow and arrange his arms in a comfortable posture; his legs are supported by cushions so that the weight of his feet does not rest on his toes (Figs. 8 and 9). Preliminary rehearsal of the roentgenographic ritual aids vastly in lessening his apprehensions and putting him at ease. The technicians are familiar

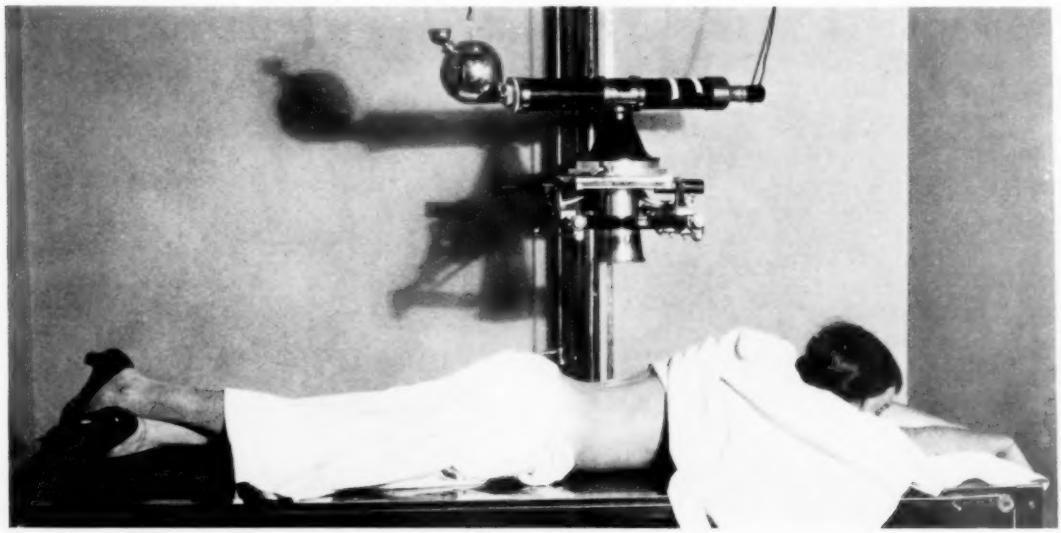

FIG. 8. Position the patient commonly assumes when placed on the table. The feet, head and arms are all in an uncomfortable position, making relaxation difficult.

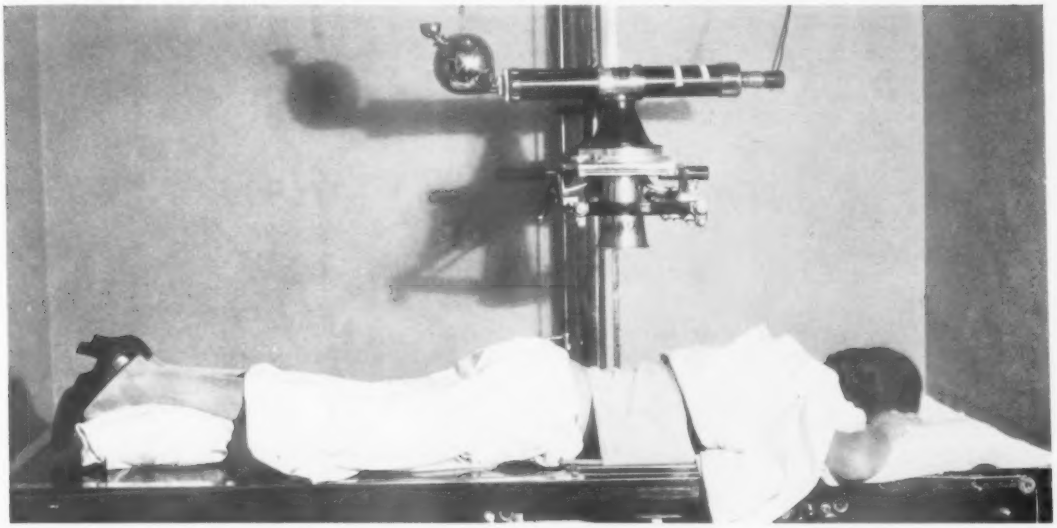

Fig. 9. A cushion under the ankles to relax the feet and legs. The patient's cheek is on the pillow and the arms are in a comfortable position. The patient is able to relax completely during exposures.

with the fact that the situation of the gall-bladder varies with the habitus; that it is likely to be high under the ribs in patients of broad build and near the pelvis in slender, asthenic persons. Therefore, correct centering of the roentgenographic field is seldom difficult. Incidentally, it may be mentioned that the site of the shadow of the gall-bladder in the film is, conversely, an excellent index of the patient's habitus and weight. It is imperative that proper penetration of the rays be secured by proportioning the voltage of the rays to the thickness of the patient, and the setting should be equivalent to that which will exhibit details of bone structure, for otherwise the fine but significant inequalities of density in the shadow of the gall-bladder will be lost (Figs. 10 and 11). A flat, Potter-Bucky diaphragm increases the clarity

Fig. 10. Normal cholecystogram which is underexposed and does not show the stones that are seen in Figure 11.

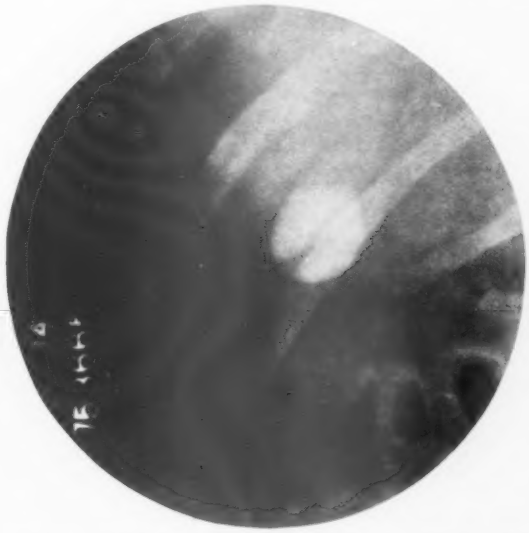

Fig. 11. Same case as that shown in Figure 10, after a proper exposure has been made.

of the cholecystogram. As soon as the first set of roentgenograms is developed, it is inspected, so that in making the subsequent sets the technician can correct errors of procedure. Intestinal gas, which is the most annoying obstacle to interpretation, is combated by requiring the patient to take an enema of warm soap suds on the morning of the test, and this also cleanses the bowel of fecal material. If, despite the enema, the shadow of the gall-bladder is obscured by gas, the technician massages the abdomen to displace the gas or requires the patient to repeat the enema (Figs. 12 and 13).

Fig. 12. Gall-bladder area obscured by gas in the colon.

Fig. 13. Same case as that shown in Figure 12, one hour after an enema which has completely eliminated the gas. A nonfunctioning gall-bladder with a large stone is revealed.

Since the advent of cholecystography more than 35,000 patients have been examined at The Mayo Clinic after the dye had been administered orally. Diagnostic results, although excellent from the beginning, have been brought much nearer to accuracy by scrupulous attention to the technical features which I have emphasized. Taking account of all errors, both positive and negative, the average of correct diagnoses is now running slightly above 90 per cent, which is virtually identical with the average reported by those who use the intravenous method of administration of the dye. On the restricted basis of positive diagnoses confirmed or negated by surgical removal and microscopic examination of the gall-bladder, the percentage of accuracy after oral administration was above 98. On adding to this list the cases in which the gall-bladder was deemed at exploration by the surgeon to be normal and was not removed, the percentage of sustained positive diagnoses is reduced to 96. As I have strongly insisted in earlier papers, the highest ratio of errors occurs in the group in which the response to the test is normal, yet disease of the gall-bladder is found at operation; in this group alone the percentage of right diagnoses falls approximately to 85. When a diseased gall-bladder preserves the ability fully to receive and concentrate bile, and contains neither stones nor growths, a normal shadow with resulting error in diagnosis is inevitable from any method at our present command. Such errors materially lower the general average of correct diagnoses. All percentages cited here were based on purely roentgenologic diagnoses, without consideration or knowledge of the clinical history. The right to consider clinical as well as roentgenologic data in interpreting cholecystograms, and to compute percentages in special cate-

gories of cases, must freely be conceded, but in contrasting statistics from varied sources every modifying element must be taken into account.

At the Clinic, in 1928, 250 patients who had been examined after the compound had been given orally were reëxamined, and at this reëxamination the compound was given intravenously; the isomer, phenoltetraiodophthalein, was employed and Graham's technique was carried out precisely. In practically all instances the shadow of the gall-bladder had been absent or extremely faint when the oral procedure was employed, and in scarcely more than 1 per cent were normal shadows secured by the intravenous method, which is the usual ratio of reversals obtained from a second examination in which the oral technique is employed. The intravenous method was therefore discarded as a method of verification to be used as a routine in doubtful cases and is now reserved for patients who have highly irritable stomachs, or for whom the oral technique is deemed unsuitable because of various unusual circumstances. Such persons are rare, and in the last calendar year the intravenous method was applied only twelve times.

The technique I have described has little claim to novelty but is presented in detail because it has proved to be thoroughly satisfactory. There is no intent to antagonize adherents of the intravenous method and no contention that other drugs and other ways of oral administration will not be equally efficient, but I am stressing the points that any oral routine should be consistent with the facts learned from experience, applied with meticulous care, and its results compared only on comparable ground with those obtained by other procedures.*

* For discussion see page 615.

FIVE YEARS' EXPERIENCE WITH ORAL CHOLECYSTOGRAPHY*

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AFTER five years of daily experience with cholecystography and the use of every known method of administering the dye, we still believe that the oral method is the most satisfactory and reliable. If there are any advantages in the intravenous, the very real dangers of this method more than counterbalance them and it is not, in our opinion, a safe office procedure. The oral method is universally applicable and in our experience has been entirely reliable as checked by operative findings. As a matter of fact, however, any dissatisfaction with the Graham test, we believe, is due to improper technique and not to whether the dye is given orally or intravenously. This subject may seem timeworn to many but the average gall-bladder examination as it is performed today shows a lamentable lack of standardization and generally films of poor technical quality. In this paper we will attempt to stress the absolute necessity for certain details in carrying out every oral test if a high percentage of operative confirmation is sought.

There is little more that can be done in a Graham test where obvious gallstones either opaque or non-opaque are demonstrated or an excellent gall-bladder outline is obtained showing normal function (see Fig. 1). But in the test when *no shadow* or only a *faint shadow* is visible, it is very easy to err. It is in these cases that most dissatisfaction with the oral test has arisen. The causes or sources of failure to obtain a shadow are numerous, the most common being due to faulty technique. Roentgenograms of diagnostic quality may vary widely in almost any branch of roentgen diagnosis and correct interpretations still be possible. In the Graham test, however, only the best quality of work can be tolerated or pathology will surely be missed. It is everyone's experience that if fifteen films in a Graham test are compared that even though technically the films are much alike and all are of good quality, the intensity of the gall-bladder shadow may vary considerably. When two examinations are made of the same patient and under identical conditions, the gall-bladder shadow obtained will occasionally vary from absence of shadow to a satisfactory outline. For this reason, alone, numerous films for comparative study are essential in successful tests.

What constitutes a satisfactory cholecystographic examination? In brief, standardized technique, good quality films and plenty of them. Technical procedures cannot be routine or left to technicians to carry out. The films must be personally inspected by the roentgenologist as taken and the examination fitted to the individual as necessity arises. The proper drug, protected from light and air, given fresh to the patient and with insistence that all food be avoided during the fasting period is the usual method. The tetraiodophenolphthalein is given in one dose in the average adult of 150 pounds, the contents of an ampule containing 3.5 grams of the dye being thoroughly mixed with a glass of sarsaparilla.[1] In making this mixture it is well to use a large glass about half filled with the sarsaparilla, and then to stir it thoroughly until effervescence is complete, before the dye is slowly added. This should make a coffee and cream colored mixture, which is quite palatable. It is absolutely necessary to prescribe the dye in known amount and the dosage must be controlled by the weight of the patient. The standard "take one bottle" dosage of the average commercial preparation is unfitted for the hundred pound woman

[1] Stewart, W. H., and Illick, H. E. *Radiology*, 1928, *11*, 271–280.

* Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23–26, 1930.

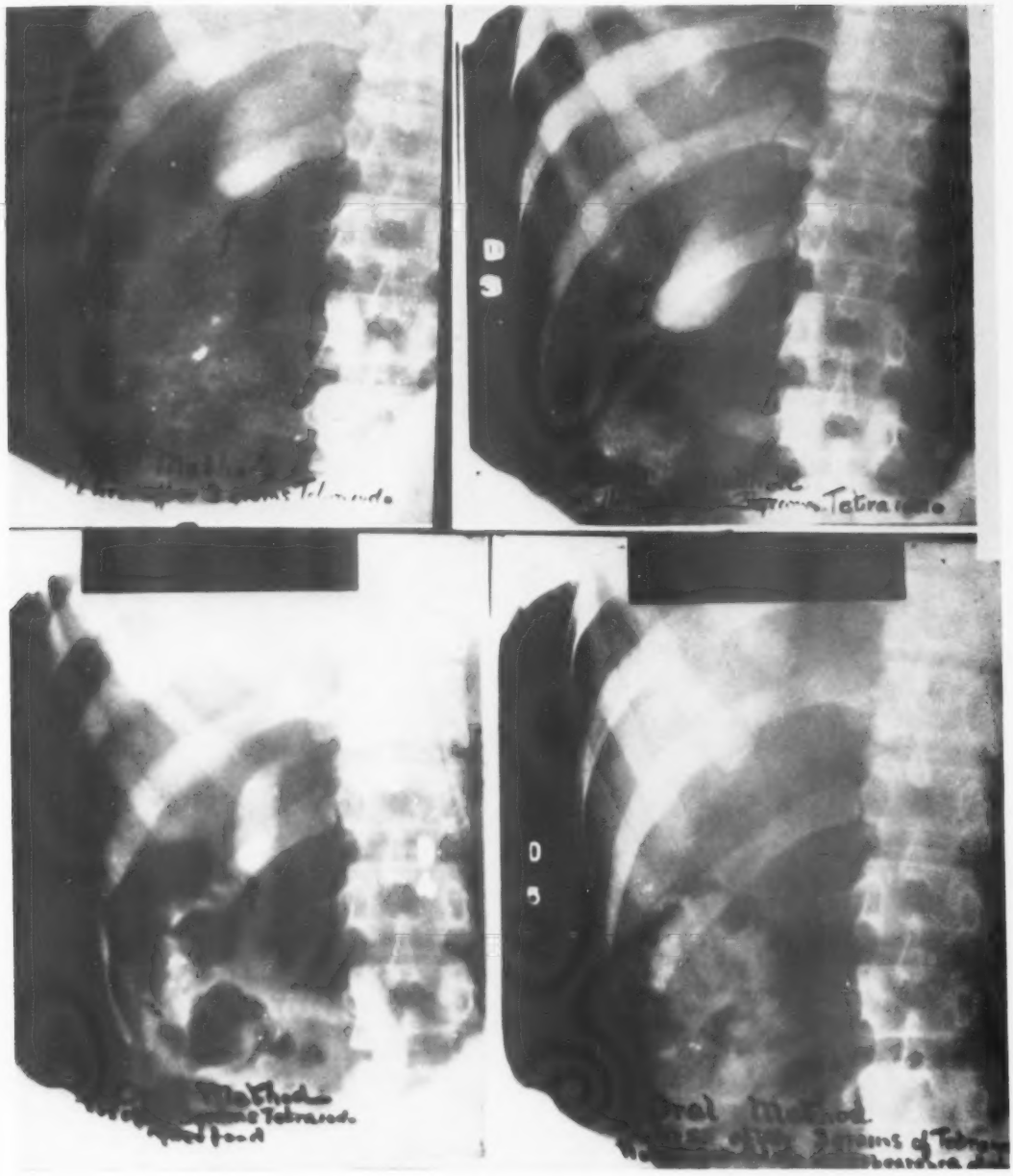

Fig. 1. Normal sequence. At the twelfth hour, dilatation; sixteenth hour, concentration; after eating, demonstration of emptying; at thirty-sixth hour complete disappearance of shadow.

in the same quantity as the two hundred pound man.

The objection to the capsule method of administration is that some of the fragments are visible at times in the intestinal tract. These can be removed by an enema at the sixteen hour examination. Such a procedure also clears the intestines of gas and is to be recommended as a *routine procedure*. Patients must be asked if there was vomiting or diarrhea; neither is important in interpreting the results unless occurring soon after administration of the dye. The character of the vomitus, i. e., whether blue in color or not and also whether the dye is recognizable in the intestines on the films

FIG. 2. This is about our workable standard. There are variations within normal limits. The question is frequently asked how we recognize "faint shadow." First one must establish a standard of density with his own technique. This is accomplished by prolonged study in normal cases. Persistent lack of this proper density is recognized as "faint shadow."

are other factors. If the shadow of the gallbladder is faint at the sixteen hour examination, have the patient starve for three or four hours longer and then reexamine. Or if gas is present in the hepatic flexure, have an enema given before additional films are taken. Many times a shadow is revealed which previously had been completely missed behind the gas. Gas in the stomach or duodenum may be removed by having the patient swallow a few sips of water and take a few deep breaths. All films must be of good quality with excellent soft tissue detail; right kidney and liver border must be sharply outlined. Clear detail of the bony structure of the vertebral bodies and ribs should be discernible. The edge of the psoas muscle should be prominent.

One of the fundamental details is the absolute necessity of educating the patient to suspend respiration while the films are being exposed. Just telling the patient to "hold the breath" too often results in films on which there is obvious blurring from movement. The technician must take time to explain at length that complete relaxation is essential, the nose and mouth must be held shut, breathing stopped, and all movement inside must be suspended. It is easily possible to hold the breath completely and yet contract the abdominal muscles thus producing movement of the viscera. Any blurring of soft tissue detail from breathing while the exposure was made should result in discarding the negative. Fuzziness and lack of detail is always present on such films. Time and again faint shadows of gallstones are plainly seen on two or three films out of a series of ten or fifteen, lack of absolute immobility being the cause of the failures.

All examinations must show the liver border before the roentgenologist reports "no shadow." The region of the spine should always be closely examined for a gall-bladder shadow as the angle at which

FIG. 3. Faint shadow without evidence of stone. See Figure 1 as standard. Roentgen interpretation was chronic cholecystitis confirmed at operation (Case 50 in Table 1).

Fig. 4. Faint shadow with mottling. Roentgen diagnosis was chronic cholecystitis with stones; confirmed at operation (Case 44 in Table 1).

the patient was taken might not have been correct. It is startling how intense a gall-bladder shadow may be and yet be completely hidden by the spine. Especially is this true in the asthenic type of patients where the gall-bladder is often in the angle between the lumbar vertebrae and the pelvis.

The routine procedure should be to repeat the examination in every *no shadow* case even though the roentgenograms seem satisfactory the first time. Then, perhaps, to his surprise the investigator will find that he has obtained an excellent shadow the second time when none could be seen on the first attempt due to some fault in the technique.

Incidentally, reports of *no shadow* should include a statement that stones are usually present with such findings (about 65 per cent of such cases). Busy surgeons and clinicians may hastily read a roentgen report consisting of *no shadow* findings and fail to understand that stones can be present under such circumstances. At least they may inform you that stones were found at operation and that you did not report them present.

The finding of *faint shadow* has been difficult to interpret and has been a disputed topic of discussion ever since the advent of cholecystography. Any interpretation must be based on entire confidence in the technical factors of the examination, combined with experience obtained from careful checking of the roentgen report with the operative findings in a series of cases. If the clinical findings are not decisive and there is any question about the findings of *faint shadow*, a re-examination is absolutely indicated. The range of normal variation of intensity of the shadow is so great that one must recognize *faint shadow* by standardization and long experience with normal cases (see Fig. 2). We often venture a positive diagnosis of pathological involvement when the shadow is persistently faint during two separate examinations (see Fig. 3) and this faintness of shadow is accom-

Fig. 5. Faint shadow with evidence of stone. See Figure 1 as standard. Roentgen diagnosis was chronic cholecystitis with stones; confirmed at operation (Case 49 in Table 1).

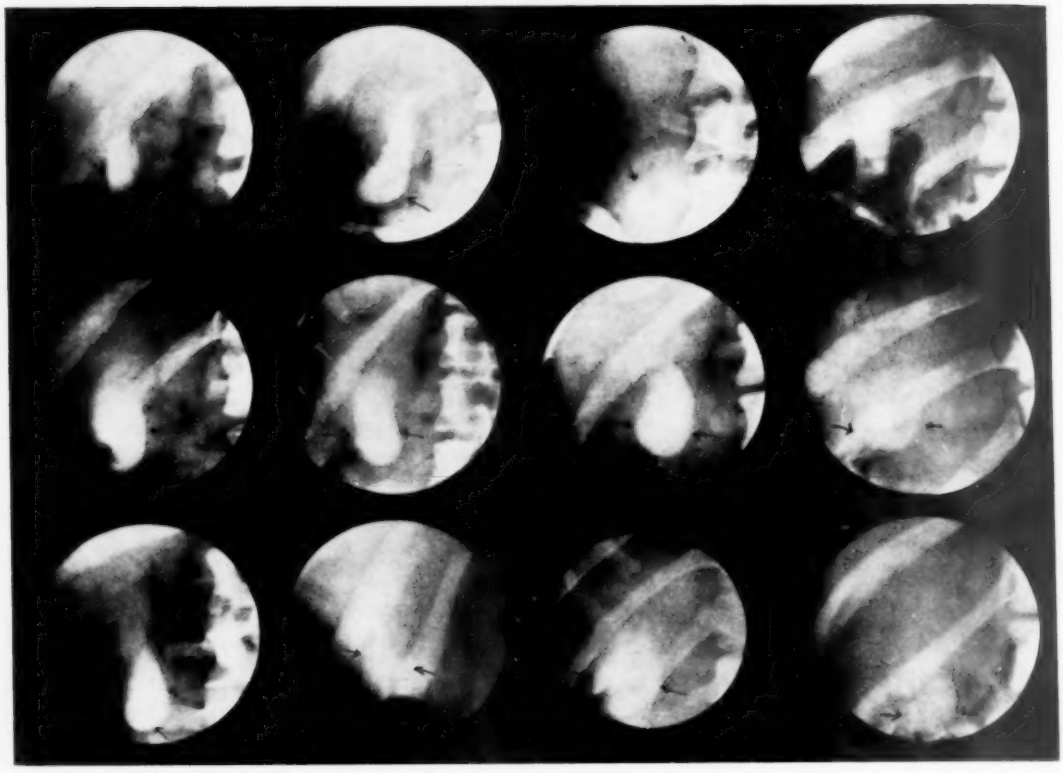

FIG. 6. Demonstrating the normal shadow in 12 consecutive cases by the oral method.

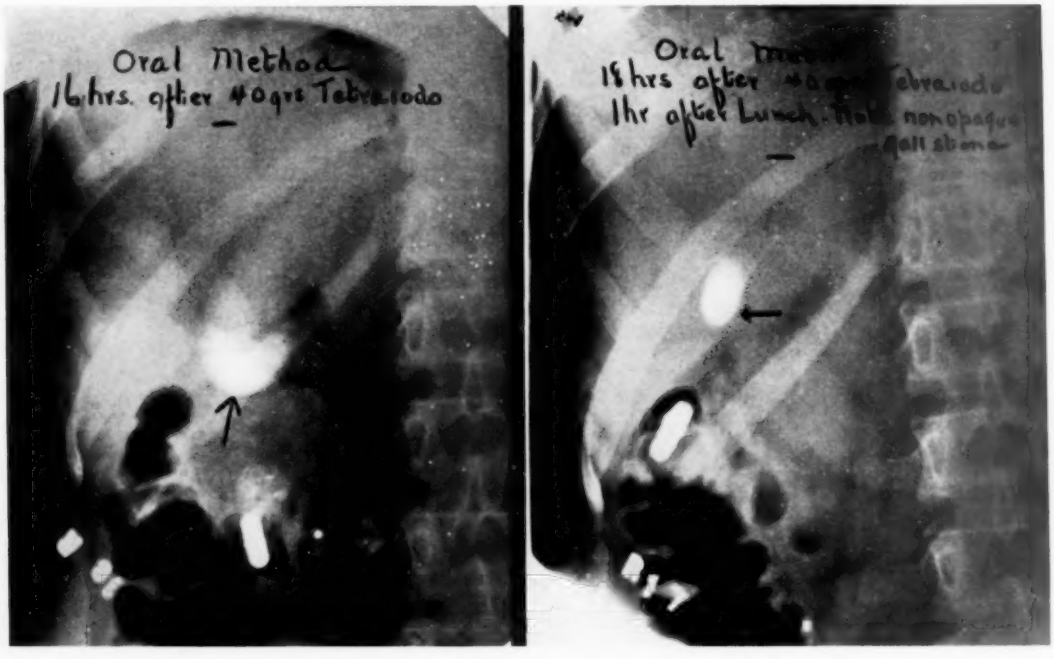

FIG. 7. As the gall-bladder empties after the meal the shadow of the stone is uncovered. It is invisible in the film taken sixteen hours after the dye.

panied by other supporting roentgenological signs such as poor concentration, sluggish emptying or stones (see Figs. 4 and 5). It is of no significance to find a faint shadow on one or two films of a series when others demonstrate a satisfactory shadow. About 60 per cent of our cases of *faint shadow* are combined with non-opaque stones which cast shadows too indefinite to be recognized.

Slight, barely perceptible jaundice; extrinsic obstruction of the cystic duct; duodenal ulcer; fever from some other cause than cholecystitis; obesity; pregnancy; cancer of the stomach; some cases of vomiting and diarrhea; hepatic pathology when the gall-bladder is uninvolved; severe pancreatic disease; advanced renal lesions and especially faulty technique, as well as many other causes may account for a faint shadow. Nothing will aid more in the correct interpretation of such findings than repeating the test.

In an effort to learn how reliable the oral Graham test was in the normal, 12 *consecutive* cases were examined (see Fig. 6) consisting of internes, hospital workers and volunteers. Nine gave a normal shadow immediately; 3 required a second examination to demonstrate a satisfactory shadow, the first being faint or not visible at all. The reason for not obtaining a shadow on the first examination is questionable but probably due to some fault in technique or lack of complete cooperation by the patient.

Not wishing to leave any method untried, the intravenous route was attempted in some of the hospital cases where two oral examinations had already resulted in *no*

Fig. 8. Gall-bladder at twelve hours. Calcified stone visible apparently in gall-bladder.

Fig. 9. Gall-bladder after lunch contracts away from the stone. At operation stone was found in right kidney confirming the roentgen report of nephrolithiasis

shadow findings. *We never obtained a shadow where none had resulted with the oral method.* In several cases decided reactions followed the intravenous administration. The injections were given by a skilled house resident unusually well qualified for intravenous medication.

The chief modification of the Graham test which we have been using lately is the more extensive study of the cases after the emptying meal. As the test was originally performed, only one examination was made about an hour after eating. Many times the gall-bladder had completely emptied when the patient returned and this examination was considered incomplete. Moreover, it was found that when the gall-bladder was half contracted, shadows of cholesterin stones were best demonstrated within the gall-bladder and distinguishable from extraneous shadows such as gas (see Fig. 7). The study of the gall-bladder during emptying is often of great value in the differentiation between cholelithiasis and nephrolithiasis (see Figs. 8 and 9). So we began making examinations of these patients *immediately* after eating and later as indicated by the rate of emptying of the gall-bladder. We also believe that the rate of emptying might vary sufficiently to be of pathological significance. The chief value of this modified method of examination has resulted in being able to *positively rule out the presence of gallstones* when a contracted gall-bladder shadow is obtained. To be able to rule out calculi is of interest to the surgeon, and to demonstrate the degree of contractility of the walls is of interest to the internist. It adds considerable information to the report of the normal cholecystographic examination. Frequent observation of the gall-bladder during emptying also enabled us in many cases to study the outline of the common and cystic ducts (see Figs. 10 and 11).

We are opposed to the routine, simultaneous barium and cholecystographic examinations since the barium-filled organs often overlie the gall-bladder and interfere with its visualization.

Other investigators stress the importance of roentgenoscopy as a practical aid in the detection of imperfect emptying. We have made numerous attempts without success to visualize contractions of the gall-bladder although we have been able at times to detect localized tenderness over the gall-bladder by palpation under the screen. Fixation of the gall-bladder with adhesions is difficult to recognize roentgenoscopically unless the patient is favorable. In our experience roentgenoscopy only corroborates the roentgenographic findings.

It is interesting to note that in our series of *no shadow* cases during the last two years 30 were operated on and the diagnosis was confirmed in all but one. This case (No. 17) had two examinations by the oral method and both resulted in no shadow. At operation the gall-bladder was reported as flaccid and normal; a scar of a duodenal ulcer was found which we do not believe influenced the findings. The gall-bladder

Fig. 10. Demonstrating the value of studying the gall-bladder during emptying. At a certain period, not always the same, the ducts are well shown.

was not removed and there was question whether it was diseased. One case (No. 16) the surgeon reported as a large, distended gall-bladder with no stones and no adhe-

sions; it was not removed but we are reporting the case as positive.

In our series of *faint shadow*, 20 were operated on, confirming the roentgen diagnosis. In many of these cases faintness of shadow was combined with other roentgen findings such as stones, poor concentration or sluggish emptying. In one case (No. 37) the gall-bladder shadow was faint at twelve and sixteen hours but seemed normal after the patient had eaten. It was reported as negative. Appendectomy was done. The gall-bladder was apparently normal and was not removed.

Fig. 11. Ducts as outlined during emptying of the gall-bladder.

In studying the microscopical findings of these cases, particularly with reference to the condition of the mucous membrane, we note that the changes are much more frequently found in the outer layers than in the mucous membrane so that the function of contractility would be interfered with more than that of concentration. This is one of the main reasons why we began a more extensive study of the contraction of the gall-bladder after eating.

The series shown in Table 1 conclusively demonstrates the serious pathological lesions that are a cause of faintness of shadow and which are practically the same as result in no shadow. Distinction on any pathological basis between the two groups is difficult and should stimulate the roentgenologist to more careful interpretation of the cholecystographic findings. In conclusion, let us say that the true value of cholecystography is not alone the recognition of stones but the ability to interpret pathology correctly based on faint and no shadow findings.

Table I

Comparison of Cholecystographic, Operative and Pathological Findings in a Series of "Faint" and "No Shadow" Cases*

Case	Cholecystographic	Operative	Pathological
1, K.B. 26253	Two orals No shadow	Chronic cholecystititis; cholelithasis; cancer of pancreas	Drainage—no specimen
2, E.D. 24145	Oral No shadow	Cancer of gall-bladder; mass size of grapefruit	Inoperable
3, I.S. 25124	Oral No shadow	One large stone; enlarged gall-bladder with tumor	Cancer of gall-bladder; large polyhedral epithelial cells; no acini; many nuclei exhibit mitoses
4, C.O. 25672	Oral No shadow	Distended gall-bladder few adhesions at neck; large stone in cystic duct	Congestion and edema of wall; fibrous hyperplasia in subserous; mucous membrane thin and atrophic. Several small hemorrhagic areas; all layers of wall infiltrated with inflammatory cells

* All these reports are necessarily greatly abbreviated.

TABLE I (*Cont.*)

Case	Cholecystographic	Operative	Pathological
5, J.N. 25587	Two orals No shadow	Enlarged, tensely swollen gall-bladder; many stones; 30c.c. seropurulent fluid	Acute suppurative and chronic cholecystitis with stones; extensive necrosis involving all layers: wall infiltrated, thickened by fibrosis
6, A.B. 24021	Oral No shadow	Small gall-bladder; thickened walls; adhesions; many small stones	Thickening of submucous coat; connective tissue and round cell infiltration in scattered areas in submucous and muscular layers; chronic productive cholecystitis with stones
7, M.G. 24054	Two orals No shadow	Numerous stones	Mucous membrane intact; submucous connective tissue markedly increased and of hyaline character; focal infiltration with round cells; scattered areas of round cells in muscular layers; chronic productive cholecystitis
8, I.M. 23702	Oral No shadow	Stone at papilla of Vater; common duct obstruction; adhesions	Mucosa thickened and arranged in low papillary formation. Submucous connective tissue thickened and diffusely infiltrated with round cells; also small round cell infiltration in muscular layer
9, M.K.	Two orals Intravenous No shadow	Acute and chronic cholecystitis with stones; edematous wall half inch thick	No microscopic report
10, J. S. 4888	Two orals No shadow	Two large stones; viscid, black bile which could not be expelled through cystic duct	Chronic cholecystitis and stones; rather marked generalized fibrosis with some fatty infiltration of the subserous coat. No ulceration. Moderate infiltration of small round cells
11, L.D. 21300	Oral No shadow	Small, thick-walled gall-bladder full of stones; one blocking cystic duct; adhesions	Acute and chronic cholecystitis with stones; cellular and vascular fibrous tissue has replaced large part of muscular coat. Large, superficial ulcers in mucous membrane with infiltration of inflammatory cells
12, V.D.	Oral No shadow	Shrunken gall-bladder filled with stones and white bile; walls thickened; numerous adhesions; cystic duct was a hard fibrous cord	Specimen given to patient's family
13, J.B. 26888	Oral No shadow	Chronic cholecystitis with stone in common duct at ampulla of Vater; adhesions	Wall sclerotic, infiltrated with inflammatory cells, mostly plasma cells; few polymorphonuclears. Mucous membrane atrophic

TABLE I (*Cont.*)

Case	Cholecystographic	Operative	Pathological
14, W.S. 26906	Oral No shadow	Cancer of head of pancreas. Gall-bladder buried in mass of cancer	Inoperable
15, M.H. 3150	Oral No shadow	Thickened gall-bladder wall; stones	Chronic ulcerative cholecystitis and stones. Mucous membrane destroyed and replaced by granulations. Wall shows generalized fibrosis and fatty infiltration of the submucous coat. Inflammatory cells scattered through wall; many large mononuclear cells
16, C.C. 3886	Oral No shadow	Large, distended, thickened walls; no stones; no adhesions; duodenal ulcer	Gall-bladder not removed
17, C.R. 22009	Two orals No shadow	Gall-bladder flaccid and normal; scar of duodenal ulcer	Gall-bladder not removed
18, M.L. 27000	Two orals No shadow	Very thick-walled gall-bladder with stones. Masses of inspissated bile-like stones in cystic duct	Chronic cholecystitis; congested wall. Outer layers thickened by fibrosis and fatty infiltration. All of the layers are irregularly infiltrated with inflammatory cells, mostly small round cells. Mucous membrane intact. Folds are elongated and in places fused together
19, J.B. 21209	Oral No shadow	Gall-bladder walls thickened; no stones. Liver enlarged; firm, brown color; suspicious for cancer of pancreas	Gall-bladder not removed
20, E.M. 23599	Oral No shadow	Small, very thick wall; no adhesions. Hazelnut stone in cystic duct; white bile	Subacute and chronic cholecystitis. Generalized fibrosis of wall. Inflammatory cells in muscular and subserous coats, round cells predominating. Congestion and edema of wall
21, T.G. 3840	Oral No shadow	Gall-bladder thickened. No stones. Cancer of liver of bile duct origin	Gall-bladder not removed
22, G.L. 4537	Oral No shadow	Gall-bladder filled with stones; no adhesions; thin wall; thick, turbid bile	Not examined microscopically
23, J.B. 27010	Oral No shadow	Small, shrunken gall-bladder. Cancer of head of pancreas involving gall-bladder secondarily	Chronic cholecystitis. Wall considerably thickened by fibrosis and moderately infiltrated with inflammatory cells

TABLE I (*Cont.*)

Case	Cholecystographic	Operative	Pathological
24, S.L. 21211	Two orals No shadow	Cancer of liver; gall-bladder adherent in mass	Inoperable
25, E.S. 24310	Oral No shadow	Very much enlarged gall-bladder with numerous stones, one blocking cystic duct; adhesions	Hydrops of gall-bladder and stones. Extreme atrophy of mucous membrane. Lining membrane epithelium flattened out. Muscularis atrophic. Slight fibrosis and chronic inflammatory infiltration in all of the layers of the wall
26, K.J. 24281	Two orals No shadow	Small gall-bladder; adhesions; stone in cystic duct	Acute and chronic cholecystitis. Congestion of wall with thickening from edema, fibrosis and fatty infiltration. Large hemorrhagic areas in inner and outer coats. Mucous membrane intact, except for occasional small areas of hemorrhagic necrosis
27, J.B. 27592	Two orals No shadow	Thick-walled gall-bladder filled with small stones. Adhesions. Edema of serous coat	Acute suppurative and chronic cholecystitis and cholelithiasis. Wall congested and edematous. Muscularis is replaced largely by granulations; numerous necrotic and ulcerated areas involve the mucous membrane
28, S.K. 3-27-30	Two orals Intravenous No shadow	Wall greatly thickened; cystic duct dilated; pericholecystitis	Acute hemorrhagic and chronic cholecystitis. Wall congested and edematous Numerous hemorrhagic areas in all coats. Round cell infiltration; connective tissue increased
29, E.K. 26296	Two orals Intravenous No shadow	Liver enlarged, nodular and adherent to wall and omentum; adhesive peritonitis. Gall-bladder covered by dense adhesions	Gall-bladder could not be removed
30, E.H. 24857	Oral No shadow	Thickened gall-bladder; few adhesions; one stone	Chronic cholecystitis; congestion and edema of wall; all layers fibrotic. Moderate infiltration with inflammatory cells both small round cells and a few polymorphonuclears. Mucous membrane irregular with numerous depressed atrophic areas
FAINT SHADOW			
31, S.W. 26475	Oral Faint shadow, poor concentration and emptying	Chronic cholecystitis; pancreatitis	Congested, edematous, fibrotic wall; polymorphonuclear infiltration; fibrosis marked in subserous coat; mucous membrane intact
32, L.B. 24007	Oral Faint shadow, stones	Two marble size stones	Chronic productive cholecystitis. Focal infiltration and thickening of submucous connective tissue

Table I (*Cont.*)

Case	Cholecystographic	Operative	Pathological
33, E.S. 21483	Oral Faint shadow	Acutely inflamed edematous gall-bladder with several stones; many fresh adhesions.	Acute suppurative and chronic cholecystitis. Extensive necrosis or ulceration of the inner layers; infiltration of wall by polymorphonuclears
34, I.S. 22245	Oral Faint shadow	Large distended, thick-walled gall-bladder	Chronic catarrhal cholecystitis; congestion, edema and slight fibrosis of wall; small round cell infiltration; mucous membrane thickened
35, M.S. 22321	Oral Faint shadow	Large, distended thick-walled gall-bladder with one large stone	Chronic cholecystitis and cholelithiasis. Congested, edematous and somewhat sclerotic wall with many small round cells. Many of blood vessels filled with polymorphonuclears. Mucosal folds are thickened
36, F.S. 22713	Two orals Faint on one. No shadow on other	Acutely inflamed swollen gall-bladder with several stones; many adhesions	Acute suppurative and chronic cholecystitis. Wall thickened by fibrosis and edema; infiltration with many inflammatory cells. Mucous membrane shows extensive ulceration and necrosis. Numerous hemorrhages throughout the wall
37, A.P. 27008	Oral—faint at 12 and 16 hr.; normal after eating; reported normal	Appendectomy	Gall-bladder not removed
38, S.G. 17953	Oral Faint shadow	Cancer of head of pancreas. Pericholecystitis. Wall slightly thickened	Gall-bladder not removed
39, J.H. 4023	Oral Faint shadow Stones	Large gall-bladder; stones; tumor of fundus; liver metastases	Inoperable
40, E.B. 22723	Oral Faint shadow	Gall-bladder small and shrunken; filled with many small, mulberry stones	Chronic cholecystitis and stones. Wall thickened by fibrosis and infiltration by small round cells. Outer layers congested and show areas of hemorrhage and fatty infiltrations. Mucous membrane atrophic
41, M.R. 21321	Oral Faint shadow Stones	Cancer of cardiac end of stomach	Gall-bladder nor removed. Stones palpated
42, E.S. 21483	Oral Faint at 16 hours	Acutely inflamed edematous; many fresh adhesions	Acute suppurative and chronic cholecystitis with stones. Extensive necrosis and ulceration of inner layers of the wall. Infiltration by polymorphonuclears. Muscle coat replaced by fibrous and granulation tissue
43, E.H. 22720	Normal shadow intensity. Poor contraction after eating; persists at 36 hours	Thickened wall; inspissated bile	Chronic catarrhal cholecystitis. Slight fibrosis of wall. Mucous membrane flattened and in places denuded of epithelial covering . Moderate chronic inflammatory infiltration of inner half of wall

TABLE I (*Cont.*)

44, E.L. 4610	Oral Faint shadow	Gall-bladder 8 in. long; swollen, edematous, thick wall; filled with stones, two in cystic duct	Subacute and chronic cholecystitis with epithelial proliferation and infiltration suggesting cancer in cervical region. Necrotic and ulcerated areas in mucous membrane. Hemorrhages in all the layers of the walls and infiltration with small round cells and polymorphonuclears
45, P.O. 21865	Oral Faint shadow	Gall-bladder thickened; adhesions	Chronic catarrhal cholecystitis; congestion and edema of wall; small round cell infiltration
46, E.S. 21483	Oral Faint shadow	Acutely inflamed, edematous gall-bladder; several stones; many fresh adhesions	Acute suppurative and chronic cholecystitis. Necrosis and ulceration of inner layers of wall. Polymorphonuclear infiltration. Granulation tissue in muscle layer
47, I.K. 24615	Oral Very faint	Very large, deep red and tensely distended. Single large stone in fundus	Acute hemorrhagic and chronic cholecystitis. Numerous hemorrhages throughout layers. Extreme congestion and edema. Areas of hemorrhagic necrosis in mucous membrane. Polymorphonuclear infiltration in inner half of wall. Granulation tissue in outer coats
48, C.M.	Oral Faint	Enlarged with firm thick wall. One stone in cystic duct; common duct filled with stones	Chronic ulcerative cholecystitis. Atrophic mucous membrane eroded in places. Hemorrhagic areas in stoma. Diffuse infiltration with inflammatory cells. Numerous hemorrhagic extravasations in subserous coat
49, A.L.	Oral Faint	Gall-bladder filled with small stones; thin walled; thick bile	Acute hemorrhagic and chronic cholecystitis. Congested and sclerotic wall; in places extremely hemorrhagic. Mucous membrane is thin, flattened out; lining epithelium eroded away in many places. Inflammatory cells throughout all the layers
50, J.H.	Oral Faint	Large gall-bladder; thickened wall; no stones	Chronic cholecystitis. Wall congested and thickened by fibrosis and edema. Diffusely infiltrated by inflammatory cells, chiefly small round cells. Mucous membrane atrophic

SUMMARY OF LESIONS FOUND AT OPERATION IN FAINT AND NO SHADOW CHOLECYSTOGRAPHIC CASES

NO SHADOW		FAINT SHADOW	
Total cases	30	Total cases	20
Stones	20	Stones	13
Chronic cholecystitis	25	Chronic cholecystitis	16
Acute cholecystitis	7	Acute cholecystitis	7
Cancer of the gall-bladder	3	Cancer of pancreas	1
Cancer of the pancreas	4	Cancer of stomach	1
Cancer of the liver	2	False negative	1
False positive	1		

DISCUSSION ON PAPERS OF DRS. WATERS AND FIROR; KIRKLIN; AND STEWART AND ILLICK

Dr. G. W. Holmes. Boston. One of the angles from which one should discuss this subject following the manner in which it was presented is the relative value of the two methods; this is one of those problems where you have two equally good methods of diagnosis. Those who advocate one usually do so because it works better in their clinic, and because it is more convenient for them to use.

This method of Graham's has been in use long enough now and it has been used in both ways so that any method which was not satisfactory would have been discarded long ago. Certainly the men who are using the oral method could never have satisfied the clinicians they are associated with if they were using an unsatisfactory method.

One point I would like to emphasize in connection with the intravenous method is that if that method is adopted, you must have a team arrangement such as Dr. Waters suggested to carry it out. It will not work satisfactorily in a hospital where the inspection is turned over to house officers who change every three months.

Then as regards the discomfort of the patient, in the experience I have had with both methods I can see very little difference. The patients get nauseated and have diarrhea occasionally, whichever method you use.

The importance of good technique has been emphasized.

I want to express my appreciation of Dr. Kirklin's paper, particularly his reference to tumors of the gall-bladder. This method may be of great value in detecting early disease, particularly malignant disease of the gall-bladder.

Dr. C. L. Martin, Dallas, Texas. I would like to ask Dr. Waters to more definitely define the condition in the vein which he calls endophlebitis. We either have not seen this condition or have not recognized it when we did see it. It has always been our custom to use the original iodeikon and I have been wondering whether the newer drug could be more irritating to the veins.

Iodeikon is of course very irritating when it gets outside of a blood vessel and will produce sloughs in the soft tissues. However, when such leakage does occur a severe reaction can usually be prevented by immediately injecting 10 or 15 c.c. of normal salt solution into the involved area.

We have had one accident that may be worth recounting. An inexperienced interne found it difficult to enter a vein at the elbow and attempted to inject the dye into one of the small veins in the wrist. A backflow occurred which produced a small slough and also involved the radial nerve causing an anesthesia in its distribution area. This condition lasted for many months.

I have recently happened on a point in technique which may or may not be new to you. In large patients whose gall-bladders lie high up under the liver and often near a gas-filled hepatic flexure, a film made with the patient lying on his back tends to throw the organ out where it can be more clearly visualized than in the standard gall-bladder position. This position also tends to flatten the structure out so that small stones are more easily visualized. Although the films are not so pretty I have been able on several occasions to demonstrate small stones in this way when they could not be seen in the films made in the prone position.

I would like to ask Dr. Kirklin how he handles the patient who is so nauseated that he cannot eat a large meal or for that matter any food at all before taking the dye by mouth. Such patients are frequently seen in hospital practice and it is my impression that they are likely to have a severe reaction if the dye is given without food. I hope that in closing he will be a little more specific relative to just what symptoms his patients who receive 4 gm. of iodeikon by mouth actually have. Some of them must experience some unpleasant reactions.

Dr. Walter C. Hill, Cleveland, Ohio. I am very much interested in the results of Dr. Kirklin and Dr. Stewart in using oral administration of the dye. Originally we checked the cases of non-filling with an intravenous injection, but now we have discarded the intravenous injection entirely and check our cases of non-filling with another oral administration, and find our results as satisfactory as with intravenous injection.

I would like to know from Dr. Kirklin what this large meal consists of that he gives patients. I think that is a very important thing. In the early days we used to follow the directions given on the bottles of dye. I think they proved very unsatisfactory. One must not only develop a technique which he thinks is accurate

but he must also give definite directions to the patient as to food. It makes a great difference in the results.

Dr. D. R. Bowen, Philadelphia. Just one point. Like Dr. Stewart, I have been meticulously careful with the dye. I think some others here must have noticed the method used by Carl Sandström of Åkerlund's Clinic, and I wonder how careful we need to be. You remember he had a pint bottle of the powder which was distinctly efflorescent and light in color. He takes out a spoonful with no pretense to accuracy and puts it in a glass of carbonated water and gives it to the patient. I have not seen better gall-bladder shadows anywhere.

Dr. E. P. Pendergrass, Philadelphia. I would like to ask a few questions also. It has been our experience that with grape juice, in a few patients pylorospasm develops and you do not get a free emptying of the dye from the stomach when using the oral method. I would like to ask Dr. Kirklin if he has had any experience with that.

I think an important practical matter in the use of carbonated water is that when you put the dye in the carbonated water, it causes a tremendous foam, and unless you instruct the patients to take all of the foam and carbonated water, they fail to get about half of the dye.

We have been using the dye very much as Dr. Kirklin uses it, in fact we have utilized his method, using it in water though, because the carbonated water always overfloods the glass.

Another point that I would like to ask Dr. Waters. Several years ago Dr. Christie reported on the absence of gall-bladder shadow associated with duodenal ulcer when utilizing the oral method. I would like to ask Dr. Waters if that occurs in the intravenous method.

Transposition of the viscera occurs. Last year we had two patients in which a diagnosis of pathological gall-bladder was made, and in the ordinary 10×12 film the gall-bladder, which was on the other side, was not included in the examination. Since that time we have been using at least one 14×17 film in the routine examination.

I hoped that in this symposium we would have more information given on the gall-bladders that are faintly visible. That is the group in which we need help. I must say that I do not know how to interpret faintly visible gall-bladders, and I would like to have Dr. Stewart tell us a little bit more about that.

Dr. H. K. Pancoast, Philadelphia. Personal experience is often valuable. Having taken the dye a few times I can say that grape juice is a very poor medium. It is apt to give an intense pyloric spasm. One must be careful when giving it in charged water, because of the thick mixture that may result if the gas is not largely eliminated. If it is not, you may have to eat the mixture with a spoon as you cannot pour it out of the glass. It is more like taking an ice cream soda. If you are going to take it in charged water, you had better get most of the gas out of the water before you put the dye in. It can be taken in plain water and I think that is about as good a way to take it as any.

Dr. L. R. Sante, St. Louis, Mo. I would like to ask two questions: first, have the essayists had any experience with cholecystography in children, and second: does advanced pregnancy contraindicate the use of the drug?

Dr. E. P. McNamee, Cleveland, Ohio. I would like to add some observations. I have been using the intravenous method. In those cases that have no shadows and have been operated on we have found that about 90 per cent had stones, whether you could demonstrate them by x-ray or not.

Of 525 cases examined by intravenous method, 173 have been operated on. In 39 of these, there was no shadow. The gall-bladder was not seen; no stones were visualized. At operation, stones were present in 31 of these 39 cases. Therefore, if the gall-bladder is not visualized by the intravenous method, we have found that stones are present in 83 per cent of the cases.

Dr. Waters (closing). I believe many of you feel as I do; when you get to a medical meeting you learn how much better you are doing some one thing, or how much worse your work is than some one's else. I think Dr. Kirklin and Dr. Stewart have clearly demonstrated what can be accomplished by the oral method of cholecystography when done in a careful and painstaking manner, but in my own experience my technique no doubt was poor and those that I came in contact with were poor, and for that reason I adopted the intravenous method which so far has proved more satisfactory in my hands. I must be honest, however, and say that had I obtained the technical results that Kirklin has, it is problematic whether I would have adopted the intravenous method. I am greatly handicapped today in not being able to show you my

movie film which contains not only my technique but also my cholecystograms.

Answering Dr. Martin's question, we have used the isomeric salt entirely, which is far less irritating to the tissues than iodeikon.

Endophlebitis is apparently due to rapid inflammation of the intima of the blood vessel, which becomes swollen and edematous, and the walls immediately become stuck together by the fibrin exudate and the approximation of the walls by pressure after the withdrawal of the needle. The harder and longer you compress the vein after withdrawal of the needle, the greater the likelihood of fibrosis or endophlebitis. It must be remembered that after all the dye has been injected, 50 or 60 c.c. of salt solution is allowed to run into the vein so that it has displaced the dye and blood, so there is no dye at the site of injection.

In the surgical treatment of varicose veins, the vein is injected with a strongly alkaline solution and the moment they get 30 or 40 c.c. in the segment of the vein which they desire to collapse the needle is withdrawn and the walls are pressed together by the hands and held firmly for a few minutes with the result that they become adherent and fibrosed, but not thrombosed. That is the pathology of this so-called endophlebitis obliterans which until recently I have been calling, as I believe most of us have, venous thrombosis. Of course, getting sore arms and cellulitis is entirely different, for this is due to poor technique.

I am glad the question of injecting small veins, such as the radial, was brought up because in my experience it is contraindicated, as the smaller the vein, the greater likelihood of endophlebitis. I feel absolutely positive that endophlebitis is due to the strong alkalinity of this dye and if the chemists responsible for it will make a decent chemical compound in which the pH approximates that of the blood our trouble will be entirely eliminated. There is no systemic reaction to this test as I have employed it.

With regard to uroselectan, I have not heard of an endophlebitis obliterans following its use. The absence of this complication probably rests upon the neutral reaction of the solution.

Answering Dr. Pendergrass' question, I have not had a great deal of experience with non-visualization of the gall-bladder in duodenal ulcer, except in two patients who had duodenal ulcers associated with non-visualization of the gall-bladder on account of involvement of the cystic duct by dense adhesions as shown at operation.

As to Dr. McNamee's question about blank shadows, there is very little that I can add because I think I know now what constitutes a normal first, second, third or fourth degree concentration of dye. There is just one thing I want to say in closing and that is if you are not able to reproduce the same excellent results of Stewart and Kirklin, I cannot help but feel that the intravenous method automatically becomes the method of choice.

Dr. Kirklin (closing). I am very thankful for the kind and generous discussion of my paper. In answer to Dr. Hill's question I will say that in the Clinic I have been using the following technique for over two years:

Each patient receives 4 grams of Mallinckrodt's sodium tetraiodophenolphthalein dissolved in one ounce of distilled water. It is important that the aqueous solution of this drug be not more than twenty-four hours old, therefore the individual doses should be prepared each day. The following instructions are given to the patient with the dye:

1. At 6 P.M. eat supper of usual amount, but avoid eggs, cream, butter and other fats.
2. At 7 P.M., or immediately after supper, empty entire contents of this bottle (the dye) into a glass full of grape juice. Stir well and drink all.
3. Do not take a laxative.
4. At 7 A.M. on the morning of the test take a rectal injection of warm soap suds until water returns clear.
5. Do not eat breakfast; you may drink water, black coffee or clear tea.

I am convinced that better results are obtained with a full evening meal than with a light meal, and also that the best shadows result when the dye is taken shortly after supper rather than two or three hours later.

Cholecystograms are made at fourteen and sixteen hour periods, and again at twenty hours, after the patient has taken a glass of half milk and half cream with his lunch. A Potter-Bucky diaphragm is used for all gall-bladder work, with a standard exposure of one-half to one second, with a 26-inch target film distance, varying the kilovoltage according to the thickness of the patient. It is very essential to keep the exposure time as short as possible in order to eliminate the slightest movement of the pa-

tient, otherwise gallstone shadows may be completely blotted out.

Many errors will result unless extreme care is exercised from the time the dye with instructions as to its use is given to the patient until the last set of films is exposed.

The instructions accompanying several cholecystographic preparations on the market state that the patient should eat a light evening meal and take the dye from one to three hours later. From my own experience in administering the dye in practically all conceivable ways in relation to meals of different types, I am convinced that the best results will be obtained with the above technique.

In reply to Dr. Martin's question regarding reactions encountered, I will say that we do not see any serious reactions. We keep a very careful record of reactions and, with the exception of a moderate laxative effect from the dye which every patient has, less than 2 per cent complain of any unpleasant reactions. Very few of them vomit, and unless the patients vomit within fifteen minutes from the time of taking the dye I do not think that it affects the test.

I have examined many children from six years up without any unpleasant results. They receive not more than one-half the normal dose. I have also examined many pregnant women and feel that pregnancy is not a contraindication to the test.

I wish to emphasize Dr. Stewart's statement that a satisfactory cholecystogram should show the liver and kidney shadow, but one will also observe gall-bladder movement on many cholecystograms in which there is no indication of movement of the liver or kidney shadow. It is possible to have enough gall-bladder movement in a cholecystogram of this type to obliterate small stone or papilloma shadows. I have many such cases in my collection. It is my opinion that this movement of the gall-bladder shadow is produced either by the patient's tension in attempting to cooperate or by the peristalsis in contiguous segments of the bowel.

I formerly re-examined all cases with a non-functioning result at the first examination. Two years ago I also requested a re-examination in every case giving a non-functioning result in the oral test. In the re-examination the dye was administered intravenously. The results obtained in over 300 such cases convinced me that the oral method, if carefully done, is as reliable as the intravenous and since that time I do not re-examine patients unless the cholecystograms are of unsatisfactory quality due to movement or gas in the bowel. In a non-functioning case in which I am not able to see any of the dye in the bowel I question the patient to make sure that he took the dye. If there is any doubt such patients should be re-examined.

Our experience with grape juice is somewhat different from that mentioned by Dr. Pendergrass and Dr. Pancoast, for we have had very little complaint from the patients since using the grape juice. In fact, we have had fewer complaints with our present technique than with any other previously used.

Dr. Stewart (closing). We are inclined to agree with Dr. Kirklin that the gall-bladder does vary in its function. All internal organs vary in their activity. We have no doubt that this is one of the reasons why at times our findings are different at different examinations on the same case. Edema of the cystic duct may prevent the opaque bile from entering the gall-bladder on one examination, when a few days later it may have subsided sufficiently to allow the bile to enter.

Many patients cannot take grape juice so we substituted sarsaparilla. *They both must be allowed to completely effervesce.*

Dr. Pendergrass asks how we recognize "faintness of shadow." As we have stated in our paper this can only be acquired by constant experience with the density of the shadow in normal cases for comparison. There are certain variations within normal limits which we must allow for, these borderline cases are most difficult, and often require more than one re-examination before decision can be made

We have not had a case of endophlebitis following the intravenous administration of the dye, but we are frank in saying that we do not use that method, except on rare occasions.

The slide we are showing covers the statement we made in our paper that 12 consecutive normal cases gave us by the oral method a gall-bladder shadow in all.

We believe that compression with the rubber bag is superior to that obtained with the flat band. The patient seems to have a tendency to open the ribs and bring the upper abdominal surface more perfectly in contact with the upper surface of the Potter-Bucky diaphragm when his back is pushed in by a compression bag.

We also believe that the air in the bag improves the quality of the films.

As stated in our paper, we have found it an advantage to study the gall-bladder by frequent observations during the period of emptying. Those who rely on an examination after the gall-bladder is emptied, will overlook many interesting and important findings that may help to make a correct diagnosis.

After an extended investigation we are of the opinion that duodenal ulcer cannot justly be given as a cause for "no shadow." When this finding is present in the presence of ulcer, we believe it is most likely due to an associated lesion.

We do not believe it is wise to check up on the following day. The entire examination is more or less fatiguing and a few days' rest is not bad advice, unless of course there is some urgency, in which case we never hesitate to re-examine immediately.

Only in some minor points do we seem at variance with Dr. Kirklin. We have long ceased to give what is called a "fatty meal" on the evening the dye is administered. Long experience has shown that gall-bladder and liver patients do not take kindly to fats. We usually give a thick soup, meat and potatoes, with a generous supply of butter, salad with French dressing, toast and a cup of tea. This will empty the gall-bladder so that it can fill with the opaque bile during the night.

We usually give the dye about two hours after the evening meal, which would be about 9 P.M. The reason for this is not that we expect less reaction, but because we desire to make our first observation twelve hours after the dye has been given. This is done at 9 A.M. in private work. In hospital service the evening meal is usually given about 5 P.M. The dye is given at 8 P.M. This allows the twelve hour examination at 8 A.M. the following morning.

We have tried Dr. Kirklin's idea of giving the dye directly after the meal, and failed to see any appreciable difference in the number of reactions. In fact we believe it is the condition of the patient and not the method of giving the dye that is responsible for the vomiting and diarrhea. The disadvantage is that if the dye is given directly after the evening meal it will usually be given at about 5 or 5.30 P.M. Eight A.M. the following morning is naturally fifteen hours after the dye, and not twelve hours as it should be. The importance of the twelve hour observation is to ascertain the amount of distention of the gall-bladder, and to have a standard shadow to compare with the one obtained at the sixteen hour, to ascertain the function of concentration. If we wait until fifteen hours after the dye is given for the first examination, we have passed the period of full distention and are bordering on full concentration. The gall-bladder concludes concentration in from sixteen to seventeen hours after the dye. The bile remains fully concentrated until discharged into the duodenum at the impulse of digestion.

TUBERCULOUS ATELECTATIC CIRRHOSIS OF THE LUNG

ITS ROENTGENOLOGIC SIGNIFICANCE*

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OSLER has said, "To know syphilis, is to know medicine." A modern paraphrase for the roentgenologist might be, "To know pulmonary tuberculosis, is to know the roentgenology of the chest." There are few diseases of the chest whose manifestations are so protean. Thus, for roentgenologists, it becomes a good working rule to consider every pulmonary lesion tuberculous until it is proved not to be. The following cases illustrate a type of lesion which is often not recognized as tuberculous.

CASE I (Fig. 1) is the chest of a white female, aged fifty-nine. Her chief complaint at the time of admission to the University Hospital was dyspnea, hoarseness, spells of weakness and a productive cough. She would expectorate a half cupful of yellow material in twenty-hour hours. There was no dysphagia and no loss of weight.

FIG. 1. Case 1. Lesion in right apex.

The cough was of about fifteen years' duration, during which time it had gradually become worse. A year ago she consulted a physician who referred her to a roentgenologist for an examination of the chest. The report of this examination was, "A malignant tumor, possibly an endothelioma, in the apex of the right lung connected with the mediastinum." As a result of this diagnosis, deep roentgen therapy was instituted, two series being given during the following year.

While under treatment she ran cyclic attacks of septic temperature ranging up to 102° F. These attacks were accompanied by rather severe pain in the right shoulder. With the expectoration of a good deal of pus the temperature would subside and the subjective symptoms temporarily improve. There was at no time any evidence of anemia or cachexia. There was noted, however, a progressive dyspnea.

At the end of the year it was thought that the tumor had diminished slightly in size but because of the clinical manifestations it came to be regarded as less likely neoplastic and more probably an inflammatory lesion. For this reason the patient was referred to the Bronchoscopic Clinic of the University Hospital for study.

A roentgenogram (Fig. 1) made on admission, which presented the same appearance as the initial roentgenogram made the year before, was reported as "a mediastinal or right apical tumor." The bronchoscopic examination revealed a profuse purulent tracheobronchitis and compression stenosis of the right main stem bronchus. Several sputum examinations were negative for tubercle bacilli. The Wassermann was negative. The clinical diagnosis was, "a primary tumor, benign or malignant, of the mediastinum, possibly a teratoma." A surgical consultation was had with the recommendation that an attempt be made to remove the tumor. It was thought advisable, however, that two or three bronchoscopic drainages be done before resorting to surgical intervention.

* From the Department of Roentgenology and the Section for Diseases of the Chest, Hospital of the University of Pennsylvania, Philadelphia. Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23-26, 1930.

Lipiodol instillation of the affected area gave no further information. The bronchoscopic drainages did not alter the appearance of the lesion or the condition of the patient. From the roentgenologic appearance it was subsequently suggested that the lesion might possibly be a tuberculous mediastinitis inasmuch as the trachea was being drawn toward the affected side, as is so frequent in this condition.

The patient finally came to operation. The involved area was approached through a posterior incision. A definite firm mass was found in the apex of the lung. This solid area involved the lung itself and did not arise from the mediastinum. In the center of this mass a small abscess cavity was found containing a small amount of pus. Microscopic examination of the tissue removed at operation revealed this to be a tuberculous lesion.

During the year since the operation the patient's condition has been much the same as before. There has been a more or less persistent sinus which has required opening several times for the liberation of pus. A roentgen examination about three months after operation showed practically no change in the appearance of the lesion.

Case II. The second patient gave the roentgenologic appearance shown in Figures 2 and 3. This was a colored male, aged fifty-six, who three weeks prior to his admission to the Hospital had had a spontaneous pulmonary hemorrhage. Seven such hemorrhages followed the first. None of these were severe enough to prevent him from working until Feb. 22, 1929, when at work he had quite a profuse hemorrhage which caused him to lose consciousness temporarily. This attack brought him to the Hospital.

His past medical and family history were irrelevant. The essential physical findings on admission were a slight shift of the trachea to the right, a questionable tracheal tug, and a hoarse voice. Chest emphysematous, expansion slightly diminished on the right, questionable slight dullness and granular breathing over both apices posteriorly with possible slight restriction in the motion of the right diaphragm. There was a widened aortic arch and slight generalized adenopathy.

The diagnostic impression on admission was: Aortitis, possibly with aneurysm, both luetic in origin; coronary sclerosis, with angina pectoris or at least with anginoid attacks; generalized arteriosclerosis; apical fibrosis(?), probably tuberculous.

All laboratory studies were negative with the exception of the blood Wassermann which was strongly positive. Five sputum examinations were negative for tubercle bacilli.

A roentgen examination of the chest (Figs. 2

Fig. 2. Case II. Lesion in right middle lobe.

Fig. 3. Case II. Lateral view, showing lesion in right middle lobe.

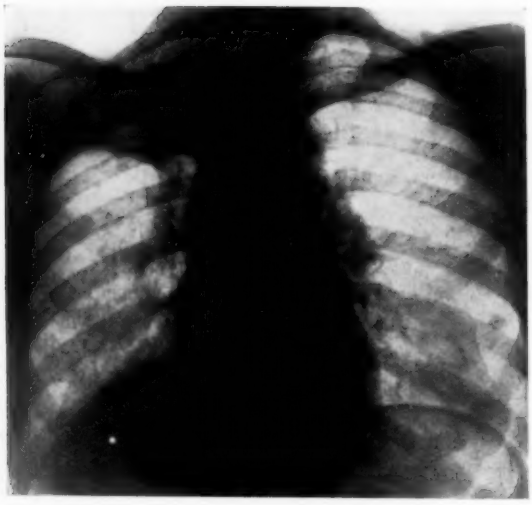

Fig. 4. Case III. Atelectatic and cirrhotic lesion involving entire right upper lobe—March, 1929.

and 3) the day following admission was reported: "Probable resolving pneumonia right middle and lower lobes."

A second roentgen examination a week later showed no change in the appearance of the chest. The following diagnostic possibilities were considered: (1) atelectasis right middle lobe due to a bronchial carcinoma; (2) pulmonary lues.

The patient had several small hemorrhages while under observation. An examination of the larynx was negative. A bronchoscopic examination was reported as follows: "The chief source of bleeding seems to be from the right lower lobe but the granulations higher up the bronchial tree could account for a considerable amount of hemorrhage." The bronchoscopic diagnosis was: "Bronchial compression. Chronic tracheobronchitis. Atelectasis."

On March 19 the patient asked permission to leave the Hospital for a day to attend to some business. His request was granted. At this time he was entirely symptom-free. His temperature during admission was around 99° F., occasionally going to 100° with a pulse rate of 70 to 108. The clinical diagnosis at this time was "generalized bronchiectasis, perhaps luetic in etiology."

The patient did not return until almost a month later. At this time he felt much better than on his previous admission. He had had no recurrence of his hemoptysis, his cough, and expectoration were much less. He had had two night sweats while at home and for five days prior to his return he had complained of a headache.

The physical examination was practically the same as during the previous admission. A roentgen examination of the chest was identical with the previous examinations. The blood Wassermann was again strongly positive.

About five days after admission the patient became apathetic, mentally confused and incontinent of urine. His temperature ranged from subnormal to 101° F. There was no leucocytosis. The blood urea nitrogen was slightly elevated. A lumbar puncture was done and examination of the spinal fluid suggested a meningitis which was thought to be of luetic origin. The spinal fluid Wassermann was negative.

Antiluetic treatment was instituted. The meningitic manifestations, however, became progressively worse. During this time there was no change in the physical signs in the chest. On the morning of April 25 the patient, without warning, had a sudden and profuse pulmonary hemorrhage and died.

At autopsy, performed by Dr. D. H. Flashman, the essential findings were a moderate syphilic aortitis, chronic fibroid and ulcerative tuberculosis of the right middle lobe with terminal hemorrhage, healed apical tuberculosis and healed childhood tuberculosis. The brain showed an acute tuberculous meningitis. Miliary tubercles were found in the liver, spleen,

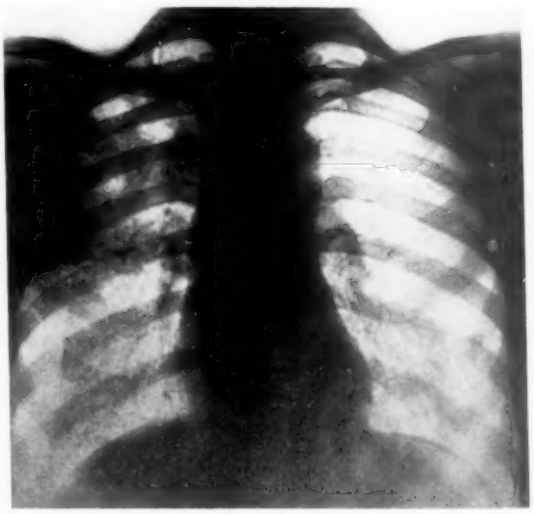

Fig. 5. Case III. Condition of chest at first examination in January, 1928. Extensive tuberculous infiltration, right upper lobe.

kidneys, prostate, adrenals and abdominal lymph nodes.

These two cases present examples of tuberculous atelectatic cirrhosis. Such lesions when encountered alone as in these patients are difficult to recognize as tuberculous either clinically or roentgenologically. Yet every roentgenologist who has had the opportunity to follow tuberculous patients by repeated roentgen examinations has undoubtedly seen the development of such lesions. To illustrate the various roentgenologic changes occurring in the lungs in the development of tuberculous atelectatic cirrhosis the following two cases are presented.

Case III. Figure 4 is a roentgenogram of the chest of a white female, aged thirty-five, made in March, 1929. The lesion in the apex of the right lung has many of the characteristics of the lesion seen in the first patient. At the time of the examination the patient was having repeated hemorrhages but in spite of this her general health was much better than at any time since coming under observation. She was first seen in January, 1928, with the history of a gradual onset two months before of gastrointestinal symptoms followed by cough, sputum, fever and a pulmonary hemorrhage. A roentgen examination of the chest at that time gave the appearance seen in Figure 5. As will be noted, there is an extensive active tuberculous lesion involving nearly the entire right upper lobe. The sputum was positive for tubercle bacilli. Under a regimen of strict bed rest she rapidly improved so that in August, 1928, a roentgenogram gave the appearance seen in Figure 6. Here we note in addition to cavitation a considerable reduction in size of the right upper lobe, the result of contraction due to marked fibrosis of the involved area. During the next five months the patient gained in strength and general health so that she was on three hours exercise daily. A roentgen study in January, 1929, showed a further reduction in size of the right upper lobe and diminution in size of the cavity present. Two months later we note the appearance shown in Figure 4, a densely cirrhotic and atelectatic tuberculous lesion involving the entire right upper lobe.

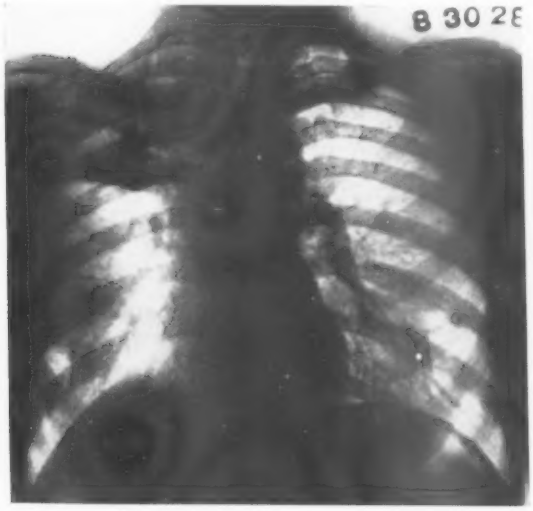

Fig. 6. Case III. Appearance of lesion in right upper lobe seven months later, August, 1928.

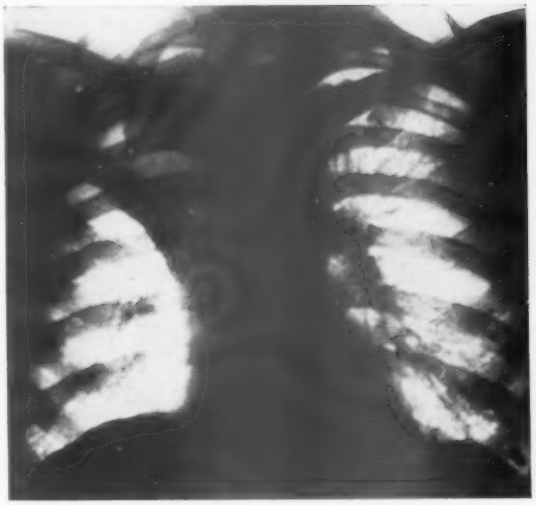

Fig. 7. Case IV. Large tumor mass, right upper chest. Examination in January, 1927.

Case IV. The next patient was a white male, aged forty-five, a roentgenogram of whose chest, made in January, 1927, is shown in Figure 7. There is an extensive lesion in the right upper half of the chest which has much the appearance of a large mediastinal or lung tumor or possibly an aneurysm. The onset of this patient's illness was six years before, in August, 1921, when he complained of a cough, weakness and loss of weight. He first came under observation in July, 1922. At this time he had, as revealed by the roentgenogram (Fig. 8), a fibrocaseous ulcerative cavitary lesion in the

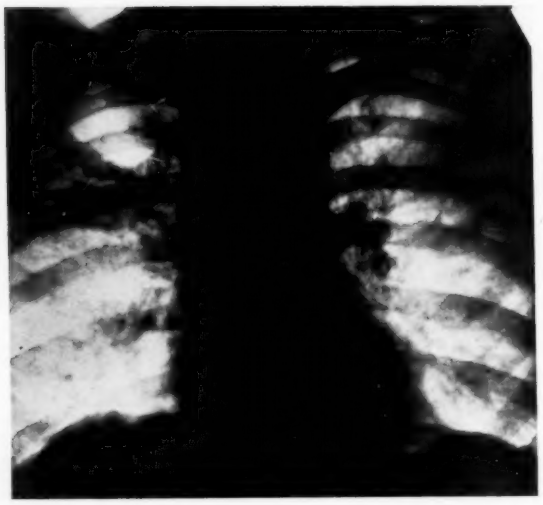

FIG. 8. Case IV. Condition of chest at the time patient was first seen in July, 1922, showing extensive tuberculous infiltration with cavitation, right upper lobe and lesser infiltration, left upper lobe.

right upper lobe and to a less extent a similar involvement without cavitation in the left upper lobe. During the following year the lesion in the right upper lobe progressed to massive cavity formation. In this period he continuously had irregular fever, at times up to 101° F., the sputum was positive for tubercle bacilli and he lost ground clinically. During the latter part of 1923 and all of 1924 he slowly improved until his temperature had become normal and he had gained considerable weight. A roentgenogram, made at this time (Fig. 9) showed in the right upper lobe a very large cavity surrounded by dense fibrosis and pleural thickening. Between the latter part of 1924 and the beginning of 1926 he was afebrile except for periodic exacerbations in which the temperature went as high as 101° F. A roentgen examination (Fig. 10) was made in November, 1925, and showed progressive healing of the right upper lobe lesion. The cavity was reduced in size and the fibrosis was more extensive. The fixation of the lesion to the lateral chest wall caused retraction of the mediastinum and heart to right. The lesion in the left upper lobe had also undergone considerable healing. During the rest of 1926 the patient gradually regained his strength and in January, 1927, he was discharged to resume his occupation as an engraver. The roentgenogram made at this time (Fig. 7) showed that the lesion had resolved itself into a cirrhotic atelectatic mass with a small cavity remaining. The trachea and mediastinum were markedly drawn to the right. There was no indication in the roentgenogram that the lesion was of tuberculous origin. The remainder of the lung fields were negative with the exception of the primary complex in the left lower lobe.

FIG. 9. Case IV. Condition of lesion in right upper lobe in 1924, two years later.

FIG. 10. Case IV. Appearance of lesion in right upper lobe a year later, November, 1925. Note that the evidence of tuberculosis in the left upper lobe has entirely disappeared.

DISCUSSION

In presenting these cases we wish to call attention to a form of healing in certain cases of pulmonary tuberculosis which in its final stage presents, in the roentgenogram, certain difficulties in interpretation. We became interested in this condition through our contact with the first case presented in which, although tuberculosis was considered it was not the final roentgenological diagnosis. The last two cases show the roentgen appearance at various stages in the healing of this type of tuberculosis and we wish now to discuss the pathologic changes responsible for the development of atelectatic cirrhosis.

In certain cases of tuberculosis the disease is rather sharply limited to a part or the whole of one lobe with occasionally only scattered infiltrations in the rest of the same or the opposite lung. If the body is able to overcome this invasion, healing of the lesion begins even though the most active parts have progressed to the formation of cavities. Healing in this type of tuber-

Fig. 12. Same patient as in Figure 11. Four months later, showing the upward displacement of the interlobar fissure.

Fig. 11. Lateral view showing position of interlobar fissure between right upper and middle lobes in a case of tuberculosis of the right upper lobe.

Fig. 13. Same patient as in Figures 11 and 12. One month later, still greater upward displacement of the interlobar fissure, accompanying decrease in size of the right upper lobe.

culosis is brought about by the encapsulation of the individual lesions by fibrous tissue which subsequently contracts, producing shrinkage of the involved area. If the lesions in the part involved are thickly enough seeded, this new fibrous tissue forms itself into dense strands which in their contraction choke off many bronchi. The shrinkage of this new fibrous tissue into a cirrhotic mass reduces the size of the area involved and also increases its density on the roentgenogram. The compression of the bronchi causes atelectasis of the uninvolved lung parenchyma between the lesions and this still further reduces the size of the diseased area and increases its density. Attention should be called to the fact that atelectasis is but a secondary and minor factor in the production of this lesion. It occurs so slowly and gradually that the classical signs of atelectasis do not appear.

If unopposed by the drag of pleural adhesions, the shrinkage and collapse of the involved area may progress to a surprising degree without causing more than trivial displacement of the mediastinal structures because the slow and gradual loss of space is compensated for by emphysema of the other parts of the same lung. If, however, the overlying pleura becomes adherent, retraction of the chest wall and displacement of the mediastinum do occur, but even here compensatory emphysema plays a large part in filling the potential empty space as can be seen from the displacement and bowing of the interlobar fissure. This is well shown in Figures 11 to 13, which are the lateral roentgenograms of a case of tuberculosis of the right upper lobe. As the lobe was reduced in size by fibrous tissue contraction, the interlobar fissure was drawn upward and emphysema occurred in the lower lobes. In cases where the overlying pleura is very much thickened, large cavities contained in the cirrhotic tissue may be blotted out in the roentgenogram.

While the principal lesion, be it a whole lobe or part of a lobe, is undergoing these changes, any other infiltrations scattered in the same or the opposite lung are passing through the same process of fibrous tissue encapsulation and shrinkage. Freed of their perifocal reaction, shrunken by fibrosis and surrounded as they are by a zone of emphysematous air vesicles, these lesions when healed may cast little or no shadow on the roentgenogram. Even if they do cast a shadow it often is not sufficiently characteristic to suggest tuberculosis and thus call attention to the true pathology underlying the major lesion.

There is one point in particular that we have found to be of value in the recognition of this condition when it occurs in the upper lobe, as it usually does. This is the displacement of the hilus on the side of the lesion. Normally the hila are both on the same level. When, however, there has been a loss of volume in the upper lobe with consequent shortening of the bronchi the hilus is drawn upward. This is well seen in the first case (Fig. 1) and to a less extent in the third (Fig. 4). An infiltrating lesion or one encroaching on the lung from without does not usually cause this shortening of the bronchi. Contracting lesions in the lower lobe cause an elevation of the diaphragm, especially of the inner half, without affecting the level of the hilus because it is easier to draw the diaphragm up than to stretch the upper lobe bronchi and draw the hilus down. Lesions in the right middle lobe have very little effect on the position of the hilus, as can be seen from the second case (Fig. 2), as traction is exerted from the anterior chest wall on the level of the hilus. When the roentgenologist is confronted by the end-result of this type of healing in tuberculosis, without an adequate or characteristic history, tuberculosis is not often considered among the diagnostic possibilities. Among the more probable conditions will be tumors of the mediastinum, exudative or infiltrative lesions of the lung parenchyma as unresolved pneumonia or malignant growths, atelectasis from complete obstruction of a bronchus by an endobronchial tumor or foreign body. The physical examination is usually of little aid in the diagnosis and the sputum ex-

aminations are most commonly negative for tubercle bacilli. A careful consideration of the roentgenogram, however, in the light of the underlying pathology as outlined above, will show that the shadow under discussion is due to a lesion producing a loss of lung volume rather than to one encroaching on the lung field from the mediastinum or increasing the volume of the lung by an exudate or new growth. This would reduce the diagnostic possibilities to atelectasis from endobronchial obstruction or to atelectasis from the cirrhotic contraction of fibrous tissue.

In all such cases bronchoscopic examination is urgently needed. Such an examination may determine whether or not the lesion is the result of an obstruction within the bronchus or whether the bronchi are being occluded by external pressure. In the former instance an opaque or non-opaque foreign body may be discovered or, as is more commonly the case, an endobronchial tumor is revealed. This need not necessarily be neoplastic as at times granulation tissue will produce complete bronchial obstruction. Such inflammatory tissue is probably most commonly of tuberculous origin. The true value of the bronchoscopic examination, however, is the determination as to whether the obstruction is endo- or peribronchial in nature.

When it is revealed that the bronchial occlusion is of the compression variety the true nature of this compression is often difficult to determine. The roentgenologic changes detailed above will usually denote the inflammatory nature of the underlying pathology. There is one type of primary malignancy of the lung, however, which may closely simulate the lesion under discussion. This lesion, which is seen only occasionally, infiltrates a lobe and is accompanied by considerable fibrous tissue formation which may or may not cause bronchial obstruction but which usually results in considerable shrinkage of the lobe involved. Inasmuch as the tumor usually arises from the bronchial epithelium it may be possible by bronchoscopic examination to establish the diagnosis definitely.

While it is recognized that any inflammatory process may produce the lesion here described, tuberculosis is by far the most common. Especially is this true in the upper lobes where this condition is most frequently found. The lesions of the lower lobes usually associated with extensive bronchiectasis which at times have the roentgenologic characteristics here described are rarely shown at operation or autopsy to be of tuberculous origin. The diagnosis is often by the process of exclusion. Healed tuberculosis elsewhere in the lungs may serve to remind one of this diagnostic possibility but is in no manner positive evidence when one considers the frequency of healed tuberculous lesions found in routine examinations of the chest. The time factor is an important diagnostic consideration; the longer the duration, the less likely is the lesion neoplastic and the greater becomes the possibility of tuberculosis.

Tuberculous atelectatic cirrhosis is far more common than is generally recognized. It is usually associated with other more discrete and characteristic tuberculous lesions so that the diagnosis is usually quite evident. The cirrhotic lesion is accepted as a part of the general tuberculous process with little thought as to the nature of the underlying pathology. It is desired, however, to emphasize the fact that the lesion may at times be the only manifestation of disease. Attention should also be called to the well-known fact that tuberculosis may be so insidious and so mild in its course that an extensive lesion may pass through all the stages of the disease without attracting attention. Thus atelectatic cirrhosis as the only evidence of tuberculosis may develop without the patient ever being sick enough to consult a physician. It thus becomes evident that in the differential diagnosis of chest pathology the roentgenologist does well to keep tuberculosis constantly in mind.

SUMMARY

1. Attention is called to atelectatic cirrhosis of the lung as a lesion which may develop in the course of healing in tuberculosis.

2. Two cases are reported in which this lesion was the only roentgenologic manifestation of the disease.

3. Two additional cases are presented to show the roentgenologic changes occurring in the development of this lesion.

4. The underlying pathology is briefly discussed.

5. The roentgenologic appearance and the salient features in the recognition of tuberculous atelectatic cirrhosis are described.

6. The necessity for the roentgenologic consideration of tuberculosis in all obscure lesions of the chest is emphasized.

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FRACTURES OF THE ANTERIOR SUPERIOR PORTION OF THE OS CALCIS DUE TO INDIRECT VIOLENCE*

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ATTENTION is called to these cases, not because we believe them extremely rare, as our record of 26 cases observed since 1920 seems to preclude such a conclusion, but from the fact that we fail to find them mentioned in the textbooks on fractures.

Most of these patients were under observation throughout the period of repair. With one exception they were industrial accident cases and we have been able to determine whether or not any permanent disability followed. With one exception the patients were all employees of two industrial plants using a certain type of truck and, with two exceptions, the injuries were all caused in the same manner.

FIG. 1. Typical example of the usual type of fracture. The majority of the cases were of this type.

In the above-mentioned plants there was in use a form of platform truck mounted on a very low running gear with small wheels. The platform of these trucks was about 8 to 9 inches from the floor. They were used to transport heavy material such

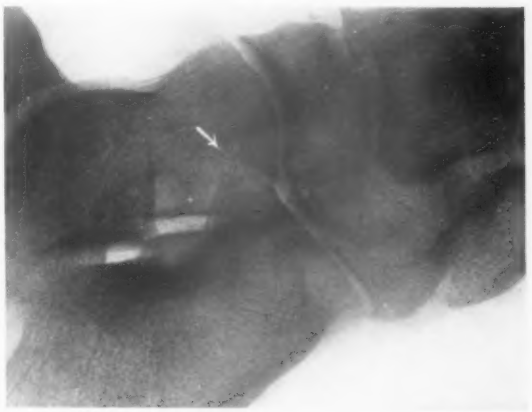

FIG. 2. Another typical example of the usual type of fracture.

FIG. 3. Another case with fracture in the usual location, but showing a much larger fragment due to the peculiar shape of this portion of the os calcis.

* Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23–26, 1930.

Fig. 4. The only case observed where the fracture occurred near the inferior anterior border of the os calcis.

as automobile frames, etc., and loads of 1000 to 2000 lb. were not uncommon. They were pulled with a tongue from the front and, owing to the heavy loads, pushed by one or two men from the rear. All of the injuries due to these trucks were caused by the truck being pushed forward and running up on the posterior aspect of the ankle of the man in front. Owing to the weight of the truck, the leg was forced forward violently, flexing the foot. Definite disability followed and weight-bearing was painful. The patients were usually referred for examination of the ankle-joint.

No injury to the ankle was found in any of the cases. Clinical examination showed no marked tenderness over the external malleolus but we found later that there was a definite point of tenderness on the external lateral border of the foot about one and a quarter inches anterior to and slightly below the lower end of the fibula. In a few cases some ecchymosis was present several days after the injury, but this was not common. Weight-bearing was painful and moderate pain followed manipulation of the foot. Fifty-eight per cent of the cases showed a definite fracture through the anterior superior border of the os calcis, the beak-shaped portion being separated from the body of the bone. In two cases the fragment was much larger, the fracture line running from about the center of the anterior border of the bone upward and backward to the superior surface of the os calcis well back under the astragulus. The remaining 42 per cent showed many variations; most of them were best described as sprain fractures. Three cases showed a small fragment of bone torn from the anterior inferior border of the os calcis. Four cases showed the fragment of bone torn from the external lateral border of the bone at or just below the superior border. In one of these the fragment was crescent shaped and was from the anterior and external lateral borders of the bone. One

Fig. 5. A number of cases of the type illustrated by this case were encountered. A typical sprain fracture. Such cases cannot be diagnosed from a lateral view and often escape notice in a routine ankle examination.

Fig. 6. Another unusual type showing a small fragment torn from the superior border near the anterior portion of the astragulus. A typical sprain fracture.

case, in which only a small fragment was torn from the lateral border of the os calcis, was associated with a complete linear fracture of the cuboid. In three of the early cases in which an early diagnosis was not made and the patients tried to work, a longer period of disability followed than in the cases in which the diagnosis was made early and weight-bearing was prohibited. In no case was there any marked displacement of the fragment. After experience obtained in the early cases, in which disability persisted for about four months, weight-bearing was prohibited for four weeks. At the end of that period plaster was applied so as to furnish as much support to the arch of the foot as possible and prevent movement in the tarsal joints, and a slight amount of weight-bearing was allowed, the patients using crutches for several weeks more. Usually in two months the patients were ready for full work. Very little complaint was encountered and in no case has there been any attempt to claim any permanent disability.

As the type of truck responsible for these injuries has been largely superseded by a power truck, very few of these cases have been observed during the last four years.

One unusual case was caused by a fall in which the patient caught his foot and fell heavily upon the leg and foot, but he was unable to describe clearly just how he fell.

This type of fracture of the os calcis is never seen associated with the usual fracture of this bone due to dropping upon the foot from a height, or to the injury sustained when dropping with a falling elevator. In fact, this anterior superior portion of the bone is not involved in the usual fractures of the os calcis unless there is extensive comminution.

In nearly half of these cases the sprain fracture could not be detected by the routine anteroposterior and lateral views of the ankle-joint and were only shown on the supero-inferior view of the foot.

DISCUSSION

Dr. Alfred L. Gray, Richmond, Va. I think Dr. Dachtler has rendered a very valuable service in calling our attention to this particular little fracture which so often escapes detection. It is such injuries that very probably lead to the well-known expression that a bad sprain is worse than a fracture. So often we have heard that from the laity. Nine times out of ten, the so-called bad sprain is due to a fracture which going untreated, has resulted in prolonged disability and often much deformity. These cases, unquestionably, will result in more or less permanent disability if not recognized. Perhaps I shouldn't say permanent disability, but at least prolonged disability if they are not recognized and go untreated without the proper support.

I thing papers of this kind render a service to roentgenologists, in general, far more than those of spectacular diagnoses.

Dr. Dachtler (closing). Just to emphasize what Dr. Gray has said about sprains, it is quite true that in these cases most of the disability is due to the associated tearing of the ligaments of all of the tarsal articulations in that region. The only thing about detection of the fracture is it calls attention to the serious nature of the injury that was sustained. I think the lack of disability is due to the fact that we have immobilized the foot long enough for the sprain rather than the fracture to heal.

A METASTATIC TESTICULAR CARCINOMA OF THE RIB

By WILLIAM NEILL, JR., M.D.

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PRIMARY tumors appearing on the ribs are usually sarcomata; however, carcinoma does occur, belonging mostly to the metastatic group, although gummata and the benign types are met with occasionally. Tuberculous and inflammatory lesions are often confusing from the standpoint of differential diagnosis. Hedblom collected 213 tumors of the bony chest wall, finding 113 sarcomata, 40 chondromata, 24 metastatic carcinomata and the remainder fibromata, exostoses and gummata, reporting no definite statistics as to the percentage of cures from treatment. He describes one personal case, a spindle cell sarcoma, on which he operated, later using roentgen radiation, but he gives no subsequent note as to the fate of the patient after seven months. Webber reports one case of spindle cell sarcoma of the sixth rib in which an extensive operation was done, the patient recovering, but he makes no statement as to the result following the month's stay in the hospital. Lund reviews the literature from the surgical standpoint of these tumors and stresses the hazards of the operation and the dangers of the anesthesia, and concludes by describing his own operative procedure but gives no data as to cures. Gatewood remarks on the difficulties of diagnosis and notes that only 15 per cent of these tumors occur on the posterior portion of the rib. Reeves and Kasabach report two cases; the first, a Ewing sarcoma, was operated upon and treated with roentgen radiation and Coley's serum. The patient survived a year. The second, an extensive case in which only a portion of the mass was removed at the exploratory operation, was diagnosed "sarcoma of the rib"; this one, treated by roentgen radiation and Coley's serum, lived seven months. In both there was relief of pain, so the authors felt justified in recommending such treatments as a palliative measure.

I wish to report a case first seen on February 22, 1922. While not proved from a pathological standpoint to be a primary or secondary rib tumor, it was diagnosed as a metastatic embryological testicular carcinoma of the fifth rib, right side, from the clinical history and pathological findings in a probable primary focus in the testicle.

The patient was a white male, aged forty, married; occupation, civil engineer. Previous to the age of nineteen, there were lung symptoms, suggesting tuberculosis; acid fast organisms were not demonstrated. He had pneumonia in 1904 and again eight years ago. At the age of eighteen, during an attack of measles, an orchitis developed in the left testicle, followed by atrophy, and in 1921 by enlargement which gradually increased in size and density. For the past eight months there has been a persistent dull, boring, aching pain in the right chest and back. In September, 1921, he received roentgen treatment over the chest without relief. Upon examination he is 20 lb. under his normal weight of 150. Temperature elevated from 99° to 100° F. The slightest movements of the body produce severe pain in the right back. Slight cough; no enlargement of lymph glands. Heart and lungs clear. No palpable mass in abdomen. Left testicle is the site of a hard, irregular mass approximately 4 cm. in diameter, mostly in dependent portion, not attached to skin. Rectal examination negative. Reflexes normal. Examining the back, the left side is a little more prominent; normal respiratory movements. On the right side, respiratory movements limited. Slight prominence over the region of the fifth rib; quite tender on pressure; no palpable tumor or irregularity. No anemia; white blood cells, 12,880, with 86 per cent polymorphonuclears; Wassermann and urinalysis negative. Roentgen examination of chest, ribs, pelvis, skull and spine, reveals complete destruction of entire posterior portion of fifth right rib with no evidence of tumor shadow or bony proliferation; all other bones normal (Fig. 1).

The left testicle was removed under local anesthesia on February 23, 1922. Gross pathology—testicle smaller than normal, occupied by a mass measuring 4 by 5 cm. Tunica smooth. On palpation the mass is quite infiltrated and

Fig. 1. Roentgenogram taken February 27, 1922, showing complete destruction of the entire posterior portion of the fifth right rib. No evidence of tumor shadow or bony proliferation; no metastases to lungs.

nodular with involvement of the epididymus. Microscopic examination shows an embryological testicular carcinoma (Figs. 2 and 3).

Radium treatment was begun on February 27, 1922, and completed on March 3, 1922; a total of 50 gram-hours at a distance of 6 inches. Due to severe pain caused by any movement of the body, the exposure was applied through the padded mattress with the patient lying prone. He was fitted with a plaster cast for support. After two weeks, the pain being lessened, he was allowed to go home. He reported by letter

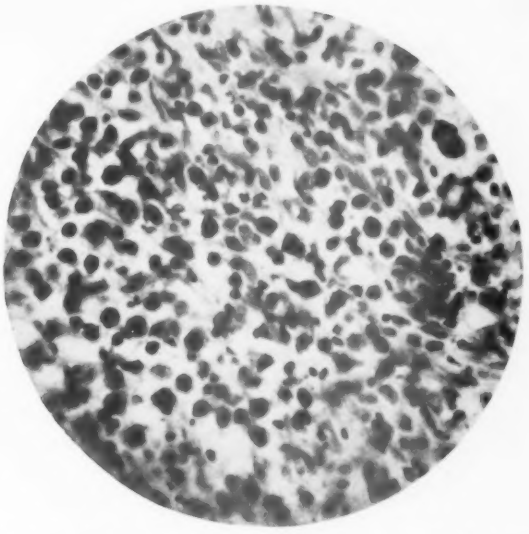

Fig. 3. Photomicrograph of primary testicular tumor (high power). Shows large round cells with large, irregular nuclei, clear protoplasm, active mitosis. Alveolar arrangement separated by thin connective tissue stroma, containing inflammatory elements. Histological diagnosis, embryological testicular carcinoma.

complete relief of pain the second week in April, 1922; the cast was discarded and he was walking about with comfort. He was seen again on May 18, 1922; he had gained 18 lb.; there was a general feeling of betterment and no return of pain. A roentgenogram revealed the rib defect filling in with new bone. Radium

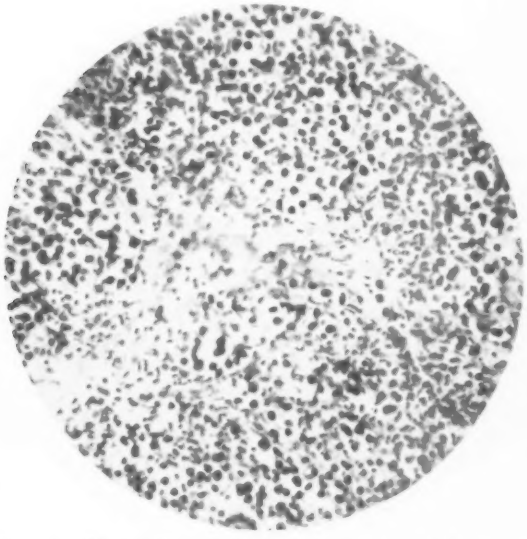

Fig. 2. Photomicrograph of primary testicular tumor (low power).

Fig. 4. Roentgenogram taken February 21, 1927, showing complete reossification of the rib; irregular margins; no return of disease.

was administered again for a total of 16 gram-hours at a distance of 3 inches. On September 16, 1922, he appeared in perfect health, weighing 156 lb., attending to his business through the summer and playing golf without discomfort. Radium was given for a total of 8 gram-hours at a distance of 3 inches. A roentgenogram revealed a complete reossification throughout the entire rib defect with only slight irregularity along the margins. In January, 1923, he continued well, weighing 164 lb. Roentgen examination showed no loss of continuity of the rib. Radium was again given, the dosage being 16 gram-hours at a distance of 4 inches. In April, 1924, physical examination showed no abnormality, which is true for April, 1925, except for a definite atrophy of the skin with moderate telangiectasis on the back at the area treated, with destruction of the sweat glands. In February, 1927, health is normal. Roentgen examination shows a completely reossified rib with no return of the disease (Fig. 4). Subsequent health splendid.

COMMENT

We have here an apparent cure by radium of a metastatic testicular carcinoma of the fifth right rib.

This patient received, in all, four treatments with radium, the first at the end of February and beginning of March, 1922, the second in May, 1922, the third in September, 1922, the fourth and final in January, 1923. Each treatment was carried to a full erythema, with variation in the distance.

The new growth occurred in an atrophied testicle.

The prompt response to irradiation is in accord with the high grade malignancies of this type.

There was reossification of the rib after extensive radium treatment.

One area only was involved by the metastasis.

Over seven and a half years have elapsed since last treatment. Excerpt from patient's letter of November 10, 1930: "I have finally reached the point where I favor golf rather than business and consequently I feel in first-class condition and hope to remain that way."

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THE EFFECT OF ROENTGEN RAYS ON THE HEART*

III. THE TOLERATION DOSE FOR THE MYOCARDIUM OF RATS

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IN TWO previous papers,[2,3] we reported the results of our experiments concerning the effect of roentgen rays on the myocardium of rats and rabbits following single or repeated exposure over the precordium. The single exposure corresponded to the so-called "average erythema dose;" for radiation as used in deep therapy, this amounts to 500–600 r (air value),[1] or 700–900 r (skin value) in a large area. While this single dose applied over the heart of rats does not necessarily lead to permanent myocardial injury, repeated exposures produced in the majority of animals definite heart lesions, even though the total dose applied did not exceed the amount of radiant energy administered according to the saturation method[4] as used in human therapy.

The next problem suggesting itself was the determination of the toleration dose for the heart muscle. This, of course, requires a large enough number of animals in order to render a statistical evaluation possible. It seemed best to study the effect of single doses only; first, to avoid a complicating factor, namely, the cumulation, and second, because certain deductions as to the effect of fractional doses can be made from the results following a single exposure.

TECHNIQUE

The technical procedure was practically the same as in the previous experiments. Rats only were used because they lend themselves better to investigations of this nature. Two types of roentgen rays were chosen in order to study as a secondary question, the influence of the wave length on the biological reaction: (1) 100 kv., 2.0 mm. Al, 20 cm. focus skin distance, lambda effective 0.34 Å (transmitted through 2.0 mm. Al), 0.7 r per second; (2) 140 kv., 0.25 mm. Cu + 1.0 mm. Al, 45 cm. focus skin distance, lambda effective 0.19 Å (transmitted through 1.0 mm. Cu), 0.2 r per second. The apparatus used was a valve tube rectifier with condenser. The field of entry amounted to approximately 1×2.0 cm.[2] Care was taken not to expose more

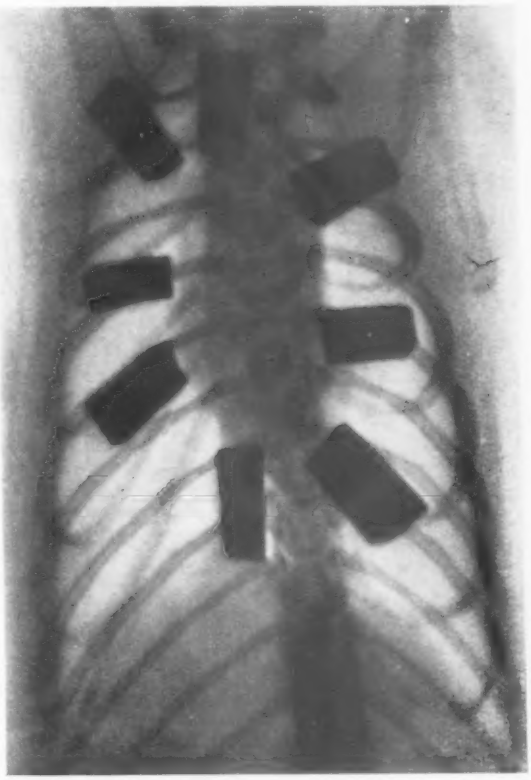

FIG. 1. Roentgenogram of the chest of a rat, showing the area as exposed in the experiments. The field was marked on the skin, the lead protection taken off and then the outline designated by small lead strips. The area within these strips corresponds to the irradiated field.

* Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23–26, 1930.

than the skin area representing the projection of the heart surface. Roentgenoscopic controls were carried out, and the roentgenogram of one animal tied to a special board made for our purpose (Fig. 1) shows that the remaining part of the body is well protected by lead of 4 mm. thickness.

The animals were subdivided into twenty groups containing from 4 to 8 rats each with one or two controls. Since all rats lived under the same conditions as to habitation, food, and care, the entire number of control animals may readily serve as controls for the whole group of irradiated rats. The doses chosen were 500 r, 600 r, 800 r, and 1000 r, as measured with the ionization chamber in air. Considering the small field used over the precordium, we assume the surface dose to be identical with the air value. The intervals between exposure and killing were one week or one month. Including the preliminary tests, 142 rats were used in this investigation (12 in preliminary tests, 104 irradiated and 26 controls).

PROTOCOLS OF EXPERIMENTS

(A) 140 kv., 0.25 mm. Cu+1.0 mm. Al; interval: one week.

Dose: 500 r

Series 11, No. 1, 2, No. 1047-LAI. Zenker's necrosis. Some fatty degenerative infiltration near endocardium. Slight pycnosis. No inflammatory reaction.

Series 11, No. 3, 4, No. 1106-LAI. Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

Dose: 600 r

Series 13, No. 1, 2, No. 1049-LAI. More marked Zenker's necrosis. Pycnosis of nuclei. No inflammatory reaction (Fig. 3).

Series 13, No. 3, 4, No. 1092-LAI. More marked Zenker's. Slight pycnosis. No inflammatory reaction.

Dose: 700 r

Series 15, No. 1, 2, No. 1091-LAI. Slight Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

Series 15, No. 3, 4, No. 1104-LAI. Marked Zenker's necrosis. Pycnosis of nuclei. No inflammatory reaction.

Dose: 800 r

Series 14, No. 3, 4, No. 1094-LAI. Zenker's. Slight pycnosis. No inflammatory reaction. One heart shows increase of stroma nuclei in outer layer.

Series 14, No. 5, No. 1098-LAI. Zenker's necrosis. Pycnosis. Increase of stroma nuclei in outer layer (Fig. 4).

Dose: 1000 r

Series 12, No. 1, 2, No. 1048-LAI. Zenker's necrosis still more marked than in 1047-LAI. Slight pycnosis. No inflammatory reaction.

Series 12, No. 3, 4, No. 1107-LAI. Zenker's necrosis. Pycnosis of nuclei. Increase of stroma nuclei in outer layer of heart muscle.

(B) 100 kv., 2.0 mm. Al; interval: one week.

Dose: 500 r

Series 17, No. 1, 2, No. 1052-LAI. Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

Series 17, No. 3, 4, No. 1097-LAI. Zenker's necrosis. Slight pycnosis. No inflammatory reaction. One heart shows slight increase of stroma nuclei in outer layers of heart muscle.

Dose: 600 r

Series 20, No. 1, 2, No. 1089-LAI. Zenker's necrosis. Slight fatty degenerative infiltration. Slight pycnosis. No inflammatory reaction.

Series 20, No. 3, 4, No. 1102-LAI. Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

Dose: 700 r

Series 18, No. 1, 2, No. 1053-LAI. Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

Series 18, No. 3, 4, No. 1099-LAI. Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

Series 18, No. 5, No. 1113-LAI. Zenker's necrosis. Pycnosis of nuclei. Increase in stroma nuclei in outer layer of heart muscle. (Most of these hearts show marked dilatation of right ventricle.)

Dose: 800 r

Series 19, No. 1, 2, No. 1101-LAI. Zenker's necrosis. Slight pycnosis of nuclei. No inflammatory reaction.

Series 19, No. 3, 4, No. 1112-LAI. Zenker's necrosis. Pycnosis of nuclei. No inflammatory reaction.

Series 19, No. 5, No. 1103-LAI. Zenker's necrosis. Slight pycnosis. Slight increase in stroma nuclei.

Dose: 1000 r

Series 16, No. 1, 2, No. 1051-LAI. Zenker's necrosis. Pycnosis slightly more marked. No inflammatory reaction.

Series 16, No. 3, 4, No. 1093-LAI. Zenker's necrosis. Slight pycnosis. Slight inflammatory reaction. Increase of stroma nuclei in outer layers of heart muscle. One definite area of myocarditis (Fig. 5).

(C) 140 kv., 0.25 mm. Cu+1.0 mm. Al; interval: one month.

Dose: 500 r

Series 4, No. 3, 4. Zenker's necrosis. Slight degree of fatty degeneration. No cellular reaction.

Series 4, No. 5, No. 560-LAI. Zenker's necrosis with small foci of inflammation in myocardium. Stroma nuclei increased. Some fatty degenerative infiltration (the only one that shows any reaction).

Series 5, No. 1, 2, No. 558-LAI. Slightly more marked Zenker's necrosis. Nuclei still present. No inflammatory reaction.

Series 5, No. 3, 4.—Zenker's necrosis. Slight degree of fatty degeneration. No cellular reaction.

Series 5, No. 5, No. 556-LAI. Slightly less Zenker's necrosis than in the others. No inflammatory reaction.

Dose: 600 r

Series 3, No. 1, 2, 3, 4, 5, 6, 7, No. 554-LAI. Same degree of Zenker's necrosis as in the preceding. Slight pycnosis. No inflammatory reaction.

Series 3, No. 8, No. 1100-LAI. Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

Dose: 700 r

Series 2, No. 3, 4, No. 1576-LAI. Marked Zenker's necrosis. Slight increase of stroma nuclei in outer layer. Slight pycnosis of nuclei. No inflammatory infiltrations.

Series 2, No. 5, 6, No. 1578-LAI. Marked Zenker's necrosis. Slight pycnosis. Slight increase of stroma nuclei in outer layers. Marked congestion of small capillaries of heart wall.

Series 2, No. 7, 8, No. 1579-LAI. Zenker's necrosis. Pycnosis of nuclei. Increase of stroma nuclei. Increased number of lymphocytes in heart wall. More marked reaction than any of the previous.

Series 2, No. 9, 10, No. 1584-LAI. Zenker's necrosis. Increase in stroma nuclei. A few mast-cells. One of these hearts shows more marked reaction than the other.

Dose: 800 r

Series 1, No. 3, 4, No. 1583-LAI. Zenker's necrosis. Increase in stroma nuclei and lymphocytes. Pycnotic nuclei of a few mast-cells around the capillaries.

Series 1, No. 5, 6, No. 1577-LAI. Marked Zenker's necrosis. Pycnosis of nuclei. No inflammatory reaction. Most marked increase in stroma nuclei in outer layer of any so far examined.

Dose: 1000 r

Series 1, No. 7, 8, No. 1586-LAI. Zenker's necrosis. Increase of stroma nuclei less marked.

Series 1, No. 9, 10, No. 1581-LAI. Zenker's necrosis. Slight increase in lymphocytes between heart muscle fibers. Slight increase in stroma nuclei. Pycnosis of capillary endothelium. One of these hearts shows more marked reaction than the other.

(D) 100 kv., 2.0 mm. Al; interval: one month.

Dose: 500 r

Series 9, No. 1, 2, 3, 4, 5, No. 553-LAI. Zenker's necrosis without any inflammatory reaction. Nuclei still present but show pycnosis. No inflammatory reaction. Nodule* consists of either bronchus or trachea, and esophagus, with a large amount of adipose tissue. No tuberculosis. One of the hearts shows a marked dilatation.

Series 10, No. 1, 2, 3, 4, No. 557-LAI. Zenker's necrosis somewhat more marked than in preceding. No inflammatory reaction.

Dose: 600 r

Series 8, No. 1, 2, 3, 4, No. 552-LAI. Zenker's necrosis slightly more marked. Nuclei show more pycnosis. No inflammatory reaction. The hearts sent under this number show slight variation of degree of Zenker's necrosis. It is more marked in some than in others.

Series 8, No. 5, 6, No. 1096-LAI. Slight Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

Series 8, No. 7, 8, No. 1587-LAI. Zenker's necrosis. Slight increase in stroma nuclei with pycnosis. Two small inflammatory areas in septum.

Dose: 700 r

Series 6, No. 1, No. 1045-LAI. Zenker's necrosis. Pycnosis of nuclei. No inflammatory reaction.

Series 6, No. 2, No. 1090-LAI. Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

Series 6, No. 3, No. 1580-LAI. Zenker's necrosis and atrophy. Marked increase of stroma nuclei in outer layers. More marked than preceding.

Series 6, No. 4, 5, No. 1588-LAI. Zenker's necrosis. Very slight increase of stroma nuclei.

Series 6, No. 9, 10, No. 1642-LAI. Zenker's necrosis. No reaction except in one place in surface of left ventricle there are small collections of lymphocytes.

Dose: 800 r

Series 7, No. 6, No. 1585-LAI. Zenker's necrosis. Atrophy. Congestion of capillaries. Slight increase in stroma nuclei with rather marked pycnosis.

Series 7, No. 7, 8, No. 1644-LAI. Marked Zenker's necrosis. No reaction.

Series 7, No. 9, 10, No. 1645-LAI. Zenker's necrosis. Increase of stroma nuclei. Congestion of capillaries.

Dose: 1000 r

Series 7, No. 3, 4, 5, No. 1582-LAI. Zenker's necrosis. Slight increase of stroma nuclei and of lymphocytes. Around some of the capillaries, large mast-cells. Pycnosis of many of the stroma nuclei.

CONTROLS

Series 1, No. 1, No. 1043-LAI. Zenker's necrosis. Slight pycnosis of nuclei. No inflammatory reactions.

* A small black nodule in the mediastinum of Rat 4 was taken out with the heart and placed in the fixing solution.

Series 1, No. 2, No. 1088-LAI. Well-marked Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

Series 2, No. 1, 2, No. 1044-LAI. Zenker's necrosis. Slight pycnosis of nuclei. No inflammatory reaction.

Series 3, No. 9, 10, No. 561-LAI. Zenker's necrosis. Pycnosis of nuclei. No reaction.

Series 4, No. 1, 2, No. 559-LAI. Less degree of Zenker's necrosis. No inflammatory reaction.

Series 6, No. 6, 7, 8, No. 1643-LAI. Zenker's necrosis. No reaction (Fig. 2).

Series 7, No. 1, 2, No. 1046-LAI. Less Zenker's necrosis than in preceding. No pycnosis. No inflammatory reaction.

Series 8, No. 9, 10, No. 551-LAI. Zenker's necrosis slightly more marked than in No. 550-LAI. No inflammatory reaction.

Series 9, No. 6, No. 555-LAI. Slightly less Zenker's necrosis than in the others. No inflammatory reaction.

Series 10, No. 5, No. 550-LAI. Slight Zenker's necrosis. No inflammatory reaction.

Series 11, No. 5, No. 1108-LAI. Zenker's necrosis. Pycnosis of nuclei. No inflammatory reaction.

Series 12, No. 5, No. 1105-LAI. Marked Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

Series 13, No. 5, No. 1087-LAI. Well-marked Zenker's necrosis. More marked pycnosis of nuclei. No inflammatory reaction.

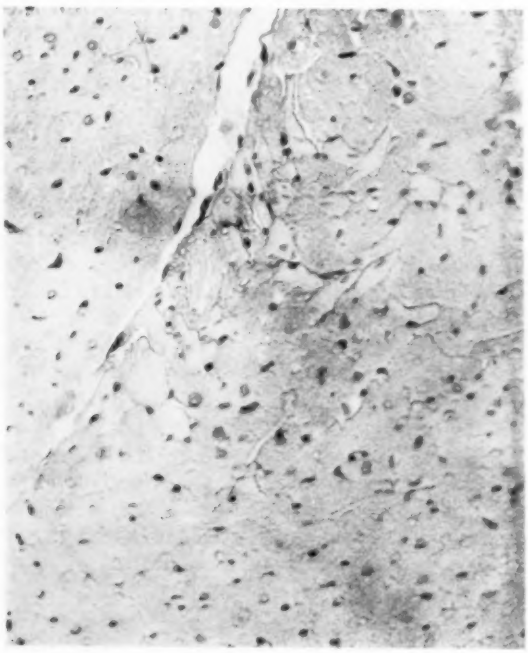

Fig. 2. Photomicrograph of section of rat's heart, showing slight degree of Zenker's necrosis.

Series 14, No. 1, 2, No. 1050-LAI. Zenker's necrosis less marked than in 1049-LAI. Slight pycnosis. No inflammatory reaction.

Series 15, No. 5, No. 1109-LAI. Zenker's necrosis. Pycnosis of nuclei. Perhaps a little more increase in stroma nuclei in outer layer.

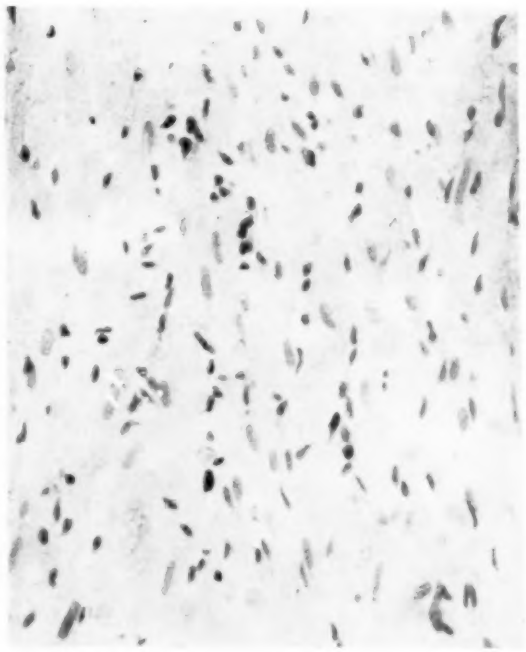

Fig. 3. Photomicrograph of section of rat's heart, showing definite Zenker's necrosis and pycnosis of nuclei.

Series 16, No. 5, No. 1095-LAI. Slight Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

Series 17, No. 5, No. 1110-LAI. Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

Series 20, No. 5, No. 1111-LAI. Zenker's necrosis. Slight pycnosis. No inflammatory reaction.

DISCUSSION OF RESULTS

A survey of the entire material shows that the microscopic changes in the hearts fall into three definite groups: first, those with Zenker's necrosis alone (Fig. 2); second, those with Zenker's necrosis and pycnosis of nuclei (Fig. 3), and third, those with Zenker's necrosis, pycnosis of nuclei, and increase of stroma nuclei with small foci of lymphocytes (Fig. 4). Before attempting a statistical evaluation of our data, several factors have to be considered.

As pointed out in the first paper of this

series,[2] slight degrees of Zenker's necrosis may in part represent a purely agonal condition, increased somewhat by the fixation of the beating heart in the formaldehyde solution. Referring also to the myocardial

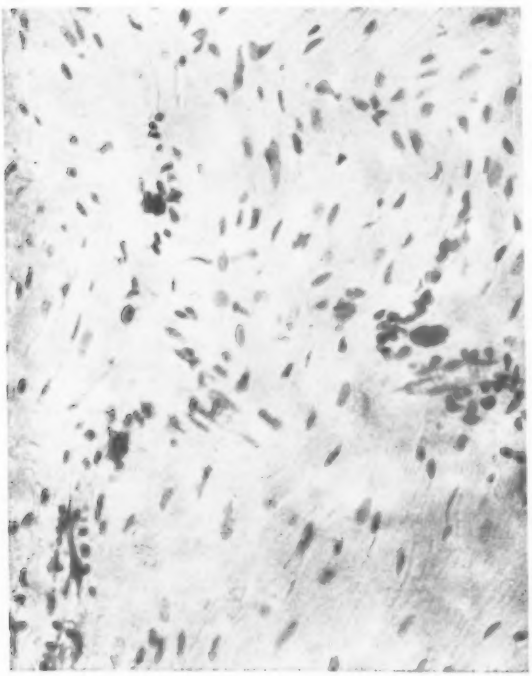

Fig. 4. Photomicrograph of section of rat's heart, showing definite Zenker's necrosis, pycnosis of nuclei, increase of stroma nuclei with small foci of lymphocytes.

changes as observed during an infection in our second series of experiments,[2] we feel that only those hearts showing Zenker's necrosis, pycnosis of nuclei, and an increase of stroma nuclei associated with small foci of lymphocytes should be regarded as injured by irradiation. While it is quite difficult to express the results of biological experiments in a formula or in figures, we have, for the sake of facilitating interpretation, made an attempt to classify the animals as shown in Table 1. Those with Zenker's necrosis only are represented by +, those with Zenker's necrosis and pycnosis of nuclei by ++, and those with Zenker's necrosis, pycnosis of nuclei, and increase of stroma nuclei by +++. If one of these three types of pathologic changes was only slight, the respective plus sign is placed in parenthesis. Table II represents the 26 untreated controls.*

A study of Table II reveals the fact that 11 of the control rats showed Zenker's necrosis, 10 had also slight pycnosis of nuclei, 4 showed definite pycnosis of the nuclei, and one showed also an increase of stroma nuclei. Since the latter happened to be the only control rat where this pathology was found, we are inclined to disregard it. The same holds true regarding the 2 rats with Zenker's necrosis and definite pycnosis of nuclei. From our experience, we would be surprised if in laboratory animals, even though kept under the best of conditions, such changes did not sometimes occur spontaneously. Since we decided to consider only those hearts with increased stroma nuclei as injured by roentgen rays, this leaves but one of the controls (3.8 per

* A complete index file was arranged for the rats, permitting a re-check of each rat from the time of entering the cages until death. The pathologist did not know whether the heart belonged to an irradiated rat or not since only code numbers were used on the specimen bottles.

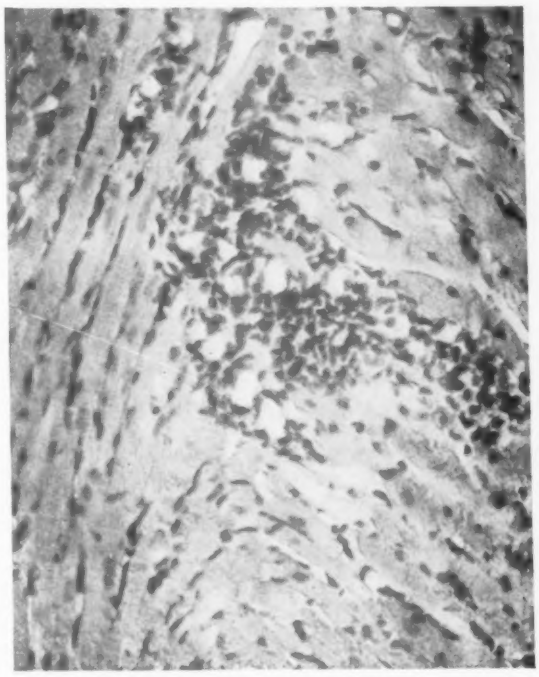

Fig. 5. Photomicrograph of section of rat's heart showing inflammatory reaction.

cent) showing changes similar to those found in the irradiated rats. Such a small percentage seems to be of little importance for our final conclusions.

The results of Table I are summarized in statistical form in Table III. For both wave lengths used in the treatment of the heart muscle, no definite injuries are seen after one week with doses of 500 and 600 r. At 700 r, the first incidence of injury occurred and with rising doses, this percentage increased. The picture is different at the one month period. A few animals seemed to react already following the application of 600 r, while beginning with 700 r, the injurious effect becomes the rule. One rat heart in the 500 r group (short wave length) showed definite pathology after one month.

TABLE I*

IRRADIATED ANIMALS

1 Week				Dose in r	1 Month			
λeff. =0.19Å		λeff. =0.34Å			λeff. =0.19Å		λeff =0.34 Å	
Rat	Path.	Rat	Path.		Rat	Path.	Rat	Path.
11:1	+(+)	17:1	+(+)		4:3	+	9:1	++
2	+(+)	2	+(+)		4	+	2	++
3	+(+)	3	+(+)		5	+++	3	++
4	+(+)	4	+(+)(+)	500	5:1	+	4	++
					2	+	10:1	+
					3	++	2	+
					4	++	3	+
					5	+	4	+
13:1	++	20:1	+(+)		3:1	+(+)	8:1	++
2	++	2	+(+)		2	+(+)	2	++
3	++	3	+(+)		3	+(+)	3	++
4	++	4	+(+)	600	4	+(+)	4	++
					5	+(+)	5	+(+)
					6	+(+)	6	+(+)
					7	+(+)	7	++(+)
					8	+(+)	8	++(+)
15:1	+(+)	18:1	+(+)		2:3	+++	6:1	++
2	+(+)	2	+(+)		4	+++	2	+(+)
3	++	3	+(+)		5	+++	3	+++
4	++	4	+(+)	700	6	+++	4	++(+)
		5	+++		7	+++	5	++(+)
					8	+++	9	++(+)
					9	+++	10	++(+)
					10	+++		
14:3	+(+)	19:1	+(+)		1:3	+++	7:6	+++
4	++(+)	2	+(+)		4	+++	7	+
5	+++	3	++	800	5	+++	8	+
		4	++		6	+++	9	+++
		5	+++				10	+++
12:1	+(+)	16:1	++		1:7	+++	7:3	+++
2	+(+)	2	++		8	+++	4	+++
3	+++	3	+++	1000	9	+++	5	+++
4	+++	4	+++		10	+++		

* For explanation of table see text.

Table II
CONTROLS

Rat	Path.
1:1	+(+)
2	+(+)
2:1	+(+)
2	+(+)
3:9	++
10	++
4:1	+
2	+
6:6	+
7	+
8	+
7:1	+
2	+
8:9	+
10	+
9:6	+
10:5	+
11:5	++
12:5	+(+)
13:5	++
14:1	+(+)
2	+(+)
15:5	+++
16:5	+(+)
17:5	+(+)
20:5	+(+)

As it is the exception, we believe that an individually increased susceptibility or some other cause for the myocardial changes may be assumed in this case. It appears then that for both wave lengths employed by us, a surface dose of 600 r or approximately 500 r effective in the heart, represents the toleration dose for the myocardium of adult rats. As far as the difference between the effect of the two wave lengths is concerned, we can only say that the histological pictures of the injuries produced by both were identical. The fact that the shorter wave length group has a higher percentage of injured hearts for corresponding doses may be due to the lower depth dose of the longer wave length. This means that for equal surface doses, less radiant energy will reach the heart in the case of the longer wave length.

Table III
STATISTICS OF RESULTS

Dose in r	1 Week		1 Month	
	0.19Å	0.34Å	0.19Å	0.34Å
500	0%*	0%	12%	0%
600	0%	0%	0%	20%
700	0%	20%	100%	70%
800	66%	20%	100%	60%
1000	50%	50%	100%	100%

*The percentage refers to the injured hearts.

SUMMARY

1. The precordium of 104 rats was exposed to roentgen rays of two different wave lengths; the effective wave lengths (Duane) amounted to 0.19 Å (140 kv., 0.25 mm. Cu+1.0 mm. Al) and 0.34 Å (100 kv., 2.0 mm. Al), on a valve tube apparatus with condenser. The dose varied from 500 r, 600 r, 700 r, 800 r, to 1000 r as measured with the ionization chamber in air. In view of the small fields used, this dose may be assumed to approximate that on the surface. Twenty-six rats served as controls. The irradiated animals were killed one week or one month following the exposure.

2. No clinical symptoms could be observed which might indicate a heart injury. The only gross pathological change consisted of a dilatation of the right ventricle. Microscopically, there was Zenker's necrosis in varying degrees, pycnosis of nuclei, and increase in stroma nuclei with small foci of lymphocytes.

3. Considering only the presence of definite Zenker's necrosis and an increase in the stroma nuclei as evidence of roentgen injury, the toleration dose for the myocardium of adult rats lies apparently at 500 r effective in the heart.

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4. Weatherwax, J. L., and Widmann, B. P. Physical factors in radiation therapy and their clinical application. *Radiology*, 1929, *12*, 297–308.

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DISCUSSION

Dr. H. P. Doub, Detroit, Mich. Dr. Warthin and Dr. Pohle's studies are very admirable in attempting to discover what is the maximum dose which can be applied to the heart of a rat without injury and also in determining what amount of irradiation will produce injury and what injury will be produced. I think that this subject requires very careful consideration, because all of us must think of the heart when we irradiate mediastinal tumors, particularly the lymphoblastomata with lesions in the region of the hilus glands and in the mediastinum.

In this paper, I think we must consider two things. First, they are talking about the rat and not the human. We cannot very easily or safely translate the effects of irradiation on animals into the effects on humans. Second, we must consider that they are talking about the acute changes. We should remember that there is a definite difference between acute changes and chronic changes and apparently in their animals it is not possible to produce chronic changes, because if large enough doses are given, these animals will die. According to their experience, these animals did not live if a certain dose was exceeded.

In our work on this same subject a few years ago, which we did from an entirely different point of view, we used dogs and sheep. We found that the sheep were not particularly satisfactory because they nearly all died of edema of the lungs and of cardiac insufficiency. The dog, however, is a very hardy animal and will stand repeated doses of heavy irradiation. I think the repeated dose is the key to producing chronic changes without sacrificing the animal. In our animals during the second month or after, we found tachycardia, extrasystole, auricular flutter and in some cases auricular fibrillation. In the latter animals we found hemorrhagic infiltration into the right auricle.

The size of the animals here, it seems to me, is the keynote to the situation, that is, if you give large enough doses to produce these changes, the animals will die.

I wish to compliment Dr. Warthin and Dr. Pohle on their work. I think it is a very admirable piece of experimentation.

Dr. Ross Golden, New York City. During the past two or three months I have had occasion to go over all of the available literature on the question of the effect of roentgen rays upon the heart. This literature contains many interesting and confusing facts, from which three stand out. One is the lack of interest in this problem until fairly recently. The second is the rather marked difference of opinion manifested in the different articles. The third is the apparent difficulty in interpreting the findings. Some writers, after examining human hearts, say that they find evidence of definite roentgen damage. Others apparently working under very similar conditions find no evidence of damage.

We have just had occasion to study the heart pathologically of a patient who received a so-called saturation series through the mediastinum in which he was given approximately two and one-half times the erythema dose during a period of about five weeks. He died about three weeks after the conclusion of that series. Our pathologist says there is nothing in the heart to suggest roentgen-ray injury. It is perfectly obvious that if enough roentgen radiation is given to any tissue, it can be damaged. The great question is whether we are damaging human hearts by giving treatment as we do at the present time. My feeling is that such damage has not yet been proved. I know of nobody who has been able to demonstrate cardiovascular insufficiency after irradiation of the heart.

The animals described in the second paper of Drs. Warthin and Pohle had pulmonary infections. I would like to ask whether such infections were found also in these animals.

Dr. H. Kennon Dunham, Cincinnati, Ohio. I had not intended to discuss this paper, but there is one note of warning which I think we should keep in mind. The heavy irradiations necessary for treatment of pathological thoracic lesions must be administered fearlessly regardless of the heart. We must not hesitate because we may do some harm. We know that

there is often a great probability of doing great good. We have all seen cases which have been exposed to heavy doses. Sometimes edema of the lung has followed. Edema of the lung frequently accompanies a bad heart. It is necessary for us to give great consideration to these papers and to exposures which may damage the heart. The edema of the sheep's lung was very striking. In all treatments we must be especially careful of the heart, because we are not dealing with young strong hearts but too often with old hearts that have been damaged long before we saw them.

In closing, let me repeat we must not get scared, but we must use every precaution. I believe that we can improve all treatments by giving a most careful examination of the heart both before and after treatments.

Dr. Pohle (closing). I wish first to express my agreement with Dr. Doub's warning. Those who have heard the entire paper noticed undoubtedly that we did not make any attempt whatsoever to transfer these findings in the animals to human pathology.

There is, however, one deduction I might make by comparison. We know that the skeletal muscle has a higher toleration for roentgen rays than other tissue, as for instance, the skin. We also know from clinical experience that the smooth muscle seems to stand heavy doses of radiant energy without serious consequences. On that basis, it appears that the heart muscle, at least in rats, is more susceptible to roentgen irradiation than the other two types of muscle. I feel that is a fairly safe conclusion to draw.

To answer Dr. Golden's question, I may say we did not observe any infections in the strain of rats used in the third series of experiments which we reported today. As a matter of fact, we examined microscopically, many of the lungs from these animals and there was no evidence of the inflammatory processes encountered in the second series.

TREATMENT OF CARCINOMA OF THE RECTUM BY RADIUM*

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THE status of irradiation in cases of carcinoma of the rectum is not well defined. There has been a steady advance in technique of irradiation, especially in cases of inoperable lesions. Results in the past have not been encouraging; they are improving, however, and it is hoped that in the future the radiologist will be of greater assistance to the surgeon.

A few patients treated by radium at The Mayo Clinic have stood out as examples of those definitely improved, since the local lesion had regressed satisfactorily under treatment. Shrinkage and inactivity of the local lesion is the best possible result obtainable by the use of radium and roentgen rays; distant metastasis cannot of course be influenced.

In order to arrive at some evaluation of the status of irradiation as applied to carcinoma of the rectum, we thought it would be of value to summarize from the literature the methods and opinions of workers in this field, and also to review briefly the technique and results in certain selected cases at The Mayo Clinic in which irradiation had proved to be of benefit.

The treatment of carcinoma of the rectum has been difficult and unsatisfactory from both the surgical and radiologic standpoints. The rather discouraging results from radium treatment have been attributed to the difficulty of approach to the lesion and to the regional lymphatics, to the radioresistance of the tumor, and to the high degree of radiosensitivity of the rectal mucosa. The attention of most observers has, therefore, been directed toward improving the technique so that more complete irradiation could be obtained, usually with the minimal amount of injury to surrounding mucosa. The first method employed was direct application of radium, in tubes, to the local lesion. This procedure, with various modifications, is still in common use.

Coffey employed radium in bulk, passing a rectal tube down through a colostomy opening and then drawing up the tube in which the radium was securely fixed until it engaged the growth. Case used a similar method holding the tube in place with dental plastic rubber. Bower suggested crossfire irradiation through a colostomy opening and one through the rectum. Pinch described the method used at the Radium Institute in London, in which a powerful radium tube is applied to the carcinoma. In cases of the annular type of carcinoma, Pinch used a tube of an activity of 200 to 250 mg., screened with 2 mm. of lead and 3 mm. of rubber, for a period of ten to fifteen hours. He suggested that a period of two to three months should elapse between exposures to avoid proctitis.

Janeway, in 1920, described a method of using small glass emanation tubes, 3 by 0.25 mm., which were evenly distributed throughout the lesion and were left in place until they sloughed out. He credited Duane with having suggested this method. He pointed out that this method was almost 100 per cent efficient and that in this way the tumor itself acted as a filter. He also recommended the method for its thoroughness and simplicity of application. Schmidt elaborated on the technique of direct application. He used radium element tubes in a

* Read at the Fifteenth Annual Meeting, American Radium Society, Detroit, Mich., June 23-24, 1930.

copper and aluminum guard 5 to 10 mm. thick. The guard was cylindrical but open on the side so that the tumor could receive a full dose of radium without danger to the normal mucosa. The apparatus was inclosed in paraffin so as to fit snugly into the rectal ampulla. This method offered only the advantage of accurate application. Quick advocated exploratory laparotomy, and colostomy if indicated, in all cases not too advanced for hope of cure. He developed the use of emanation seeds but he did not discard the earlier methods of treatment. He said: "Our own experience has been one of gradual change from applying filtered radium internally only, to a combination of buried emanation, filtered radium internally and externally, and, if necessary, surgical exposure to make the application as accurately as possible." He used buried emanation tubes 3 by 0.3 mm. with an average strength of 1 to 2 millicuries, giving a dosage of 10 to 40 mc., or a total of 1320 to 5280 mc-hr. He also applied filtered radium rays to the growth internally. For annular growths he used a string of 0.5 mm. platinum tubes, usually three to five, arranged end-to-end in a small rubber tube which was again encased in a large rubber rectal tube. He considered 500 millicurie-hours for each tube as a moderate dose without danger of reaction. In treating circumscribed lesions he inserted a solid rubber bougie into the rectum with the platinum tubes lying in grooves at its side. In this way the radium was placed in close proximity to the growth and the normal rectal mucosa was adequately protected. He also applied heavy filtered doses of radium at a distance from the skin over the sacrum, and, if the growth was higher, he applied it to the left lower quadrant as well. For this purpose he used a radium pack of 70 sq. cm. filtered by 2 mm. of brass and at a distance of 10 cm. from the skin. He considered 20,000 mc-hr. a safe dose.

Kelly and Ward worked out a technique consisting of: (1) implantation of bare emanation needle points into the diseased tissue; (2) direct application of the emanation to the diseased area, and (3) external or so-called deep irradiation, with massive doses at a distance and fired into the diseased area from several directions. They used glass capillaries carrying 0.5 to 1.5 mc. and placed throughout the tumor, allowing 1 mc. for each area of 1 c.c. of tumor tissue. The direct applications were packed in gauze or surrounded with 2 to 4 mm. of hard rubber. The average dose was 1 to 2 gram-hours. For the external application, a thick lead cylinder with portals of 2 to 3 inches was used; the areas of election were three or four over the sacrum and coccyx, one through the perineum, and (especially when the pelvic growth was extensive) to the groins and suprapubic regions. They gave 10 gm-hr. over each of four areas at a distance of 3 inches, or 40 gm-hr.

Schreiner used a combination of emanation seeds and direct application of radium to the lesion, supplemented by high voltage roentgen rays, so that the total dose approximated 130 per cent, 3 to 5 cm. from the tubes.

Muir suggested the use of removable radon seeds filtered with platinum. He considered this method an improvement over the bare emanation method in that fewer seeds need be used; the seeds are not retained to act as a foreign body, and the platinum filter permits the use of larger doses with less danger of necrosis.

Binkley used a method combining external applications with implantations of gold seeds directly into the mass. He used an element pack containing 4 gm. of radium with a filter at the portal of exit of 0.35 mm. of platinum and 1.50 mm. of brass, or an emanation pack of 2000 mc. of radium emanation filtered by 0.50 mm. of silver and 1.50 mm. of brass. The pack was applied at 10 to 15 cm. from the skin at suitable areas about the pelvis. Three portals of entry were ordinarily employed, in the median line: a posterior field over the sacrum, an anterior field over the pubis and lower part of the abdomen, and a perineal portal. When the pack was used at 10 cm. from the skin a dose of 20,000 to 22,000

mc-hr. was given at each portal, whereas at a distance of 15 cm., 50,000 to 60,000 mc-hr. were employed. He employed gold emanation seeds following the preliminary external irradiation. The gold seeds are described as being 4 mm. long, 0.75 mm. in diameter, and varying in strength from 1 to 3 mc. The dose was 1,300 to 8,700 mc-hr. Both straight and fishhook applicators were employed to facilitate application. In some cases the seeds were planted through a colostomy opening. These seeds were left in place. In selected cases radical surgical procedures were used ten to fifteen days later to remove the devitalized tissue.

Rose treated a group of patients by using element needles following colostomy. The needles he employed contained 5 to 10 mg. of radium screened by 0.5 mm. of platinum. In 5 cases the coccyx was excised and the needles were planted directly around a posterior growth. In 16 cases some of the needles were planted deeply into the perirectal cellular tissues by puncture of the perineum and anococcygeal raphe with a trocar. In order to keep the needles apart and to help protect the intact mucosa and also to allow of free drainage the bowel was packed with rubber tissue. In his series Rose gave as high as 15,300 mg-hr. divided into four exposures.

Jones varied his treatment according to the nature of the lesion. In papillary growths he used needles or emanation tubes placed throughout the growth. If there was a large flat ulceration he suggested an oval, flat applicator composed of radium tubes evenly distributed throughout. In the case of a narrow constriction, he placed tubes in tandem in a rubber container and directed it into the lumen of the bowel. His dosage varied from 200 to 300 mg-hr. in two treatments three hours apart. The radium was screened with 1.5 mm. of brass and a rubber tube about 3 mm. thick. After the reaction subsided, he gave external irradiation with roentgen rays. Further irradiation after the initial course, however, he considered to be of little value.

Many workers place considerable emphasis on the value of roentgen rays. Thus, May applied them preoperatively and postoperatively with 110 per cent skin erythema dose to the tumor in every case. He believed that patients even with demonstrable metastasis to liver and groin could be prepared for operation by the use of roentgen rays.

Von Schmieden also believed that inoperable carcinoma of the rectum could be reduced to operability by roentgen rays.

Gaarenstroom applied roentgen rays, then radium element, directly to the tumors. He placed considerable emphasis on the value of the roentgen irradiation.

Binkley, in a recent article on the advantages and limitations of external irradiation in the treatment of rectal carcinoma, made the following statement: "Experimentally, there does not appear to be a great difference in the effect of high-voltage roentgen rays and the gamma rays of radium. Clinically, however, there is a marked advantage afforded by the gamma rays. Since the 4-gram radium element pack has been added to the Memorial Hospital equipment, so that external radium irradiation could be more freely employed, there has been a marked improvement in the effect produced on rectal cancer by external treatment." It is his belief that external irradiation constitutes the first step in this method of treating all rectal carcinomas, and that in certain selected cases it may be the only form of treatment necessary.

Aron stated, in an article which appeared at the same time as Binkley's article, that external irradiation would lessen the hemorrhage from the carcinoma, diminish the toxemia from absorption, and later decrease the infection of the carcinoma, but he emphasized that carcinoma of the rectum could not be cured by external irradiation alone. He stated his belief that interstitial irradiation is the really effective method.

Neuman and Coryn recently described a method of radium treatment following surgical approach which seems to have been successful. The first step is the establish-

ment of an artificial anus. The operation is preceded by an eight-day period of rest. The operation is done under spinal anesthesia with the patient in the prone position. The anus is first closed with a purse string suture. After the coccyx is removed and the attachments of the glutei maximi and levator ani muscles are separated, the ampulla of the rectum is exposed and freed by blunt dissection. The growth itself is irradiated by means of needles 16 mm. long containing 0.6 mg. of radium and having a screenage of 0.5 mm. of platinum. The needles are introduced into the tumor perpendicularly to the axis of the rectum, if the volume of the growth permits; otherwise the needles are introduced obliquely and placed at a distance of 1 cm. from each other. The rectum beyond the growth is irradiated by means of needles 27 mm. long containing 1.33 mg. of radium screened with 0.6 mm. of platinum. The lymphatics are attacked by needles containing 2 mg. of radium; they are 33 mm. long and are screened by 0.65 mm. of platinum. The needles are placed along the posterior wall of the rectum into the concavity of the sacrum on each side of the median line; they are introduced upward at a depth of 5 to 6 cm.; they aim at the sterilization of the rectal lymphatics situated at the bifurcation of the superior hemorrhoidal vessels, also into the upper part of the right and left ischiorectal fossae to irradiate the middle hemorrhoidal area, and finally into the lower part of the ischiorectal fossae to irradiate the inferior hemorrhoidal area. The average dosage consists of fifteen needles of 0.6 mg., fifteen needles of 1.33 mg. and twelve needles of 2 mg., making a total of 52 mg. of radium. The needles are left in position seven days. The average total dose is 10,000 mg-hr. If there is a persistent discharge, amputation of the rectum is performed as a third step, with the application of deep roentgen rays, about two months after the insertion of the radium. From 1922 to 1924, forty patients were treated; the condition of 70 per cent of these was inoperable, by accepted surgical standards. Two-year cure was obtained in 52.4 per cent of the cases.

Berard found that the technique of Neuman is less advantageous, but he emphasized the importance of preliminary colostomy and in inoperable cases he used roentgen rays and radium for palliation. He also suggested the use of vaccines.

Gauducheau treated his patients according to the type of lesion. He performed colostomy in all cases and then used radium and roentgen rays, or radium and operative procedures. In selected cases he applied radium by the posterior approach according to the technique of Neuman. He did not, however, feel that his results were favorable with any of these methods.

Watson adopted the method described by Neuman and Coryn. He uses a rough standard of dosage, 10,000 mg-hr. as a maximal dose, 300 hours as a maximal time, and 2 mg. for each cubic centimeter as a unit. The needles were filtered with 0.5 mm. of platinum. He emphasized the lymphatic attack which he investigated before attacking the growth. For this lymphatic attack he used needles containing 3 mg. of radium. Two or more needles were passed up alongside the mesenteric vessels, the number depending on whether or not there were palpable lymph nodes. In the same way the lines of lymphatics spread along the middle and inferior hemorrhoidal vessels were dealt with. He expressed the belief that any method which leaves out lymphatic barrage cannot be considered radical and is comparable to local resection of an operable growth.

Gordon-Watson used the intraperitoneal route for growths which extend above the peritoneal reflection either alone or in combination with perineal, vaginal and intrarectal irradiation. He first performed laparotomy through which he explored the liver. He then examined the mesorectum and mesosigmoid for lymphatic metastasis. Whenever required, needles were passed into the mesentery in apposition with the lymph nodes; the growth was then attacked systematically and a uniform barrage was se-

cured. The pelvic colon was fixed ready for colostomy, but not opened. The needles had threads and beads attached which were brought out through the abdominal wall and sutured beneath the skin. The radium was removed after seven to fourteen days, according to the amount employed, without opening the abdomen again. The colostomy was left unopened as long as possible.

Proust treated his patients in various ways, depending on the type and situation of the growth. He expressed the belief that colostomy should precede treatment in all cases. In growths low in the rectum he used Neuman's technique, whereas in those higher he preferred abdominoperineal operation. He expressed the belief that the lymphatic spread should be checked by perineal puncture or radium tubes implanted into the perirectal space. The local treatments were followed by external irradiation by roentgen rays through six portals of entry. In the inoperable cases he used roentgen rays which he felt gave palliative relief, and in some cases reduced inoperable carcinomas to the point of operability.

At the International Conference on Cancer in London, in 1928, Regaud said: "The introduction into the rectum of radium tubes arranged in a long linear focus of suitable extent and sheathed in light materials that serve as secondary filters and allow of as great a distance effect as possible, is still the method most generally employed. This method cures only very rarely. Whether it accomplishes a cure in exceptional cases or only a diminution of the tumor, it runs the risk of producing very painful and intractable radiolesions. Radium puncture with platinum needles and the implantation of 'seeds' if applied through the internal surface of the tumor with the aid of a proctoscope, offer only very slender chances of cure and are faced with considerable difficulties of technic. There remains curietherapy from the external surface of the rectum previously exposed by operation. This radium surgery, recommended by Neuman and Coryn is only applicable to extraperitoneal low-lying carcinomas."

The value of radium in the treatment of carcinoma of the rectum is a much disputed question. To show this difference of opinion we will quote from some of the writers who have had a wide experience in this field.

Lockhart-Mummery made the statement that thus far the treatment of carcinoma of the rectum cannot be considered satisfactory, that an authentic cure cannot be claimed, that is, five years without recurrence of the tumor. After considering the surgical treatment, he gave statistics to show that when operation for carcinoma of the rectum is performed under the most favorable conditions the mortality is about 3.5 per cent and the cures on a five-year basis about 50 per cent; in especially favorable early cases the proportion of cures on a five-year basis is about 66 per cent.

Hartman reported his results in a series of 555 cases in which examination and treatment had been carried out. He stated that he has never observed a cure due to treatment by radium.

Regaud expressed his opinion as follows: "When a carcinoma of the rectum can be extirpated we recommend the complete operation in spite of its high mortality. It appears to us to be very doubtful if preliminary radiotherapy improves the results. When a carcinoma of the rectum cannot be extirpated we recommend colostomy, which has the immense advantage of resting the intestine and arresting the onset of infection of the carcinoma. It should not be forgotten that patients thus treated may live for several years with a supportable infirmity. When the painful period arrives it is time to turn to external radiotherapeutic measures (very penetrating roentgen rays, radium at a distance) which gives a passing relief."

Gant stated that radiotherapy is totally unreliable in the treatment of carcinoma in the rectum or higher, and expressed the belief that it sometimes stimulates lymphatic carcinoma to more rapid growth.

It was Burrow's belief that good results

are uncommon in carcinoma of the rectum, and that palliation is the most that can be hoped for.

Barling summarized his views as follows: "Despite the considerable mortality attached to the operation of excision of the rectum, either by combined abdominoperineal method, or by the Kraske method or some modification of it, I see no justification at present (nor until we know what degree of permanence attaches to the apparent cures by radium) for substituting, in an operable case, treatment by radium for excision, especially in view of statistics collected from three hospitals in Birmingham."

On the other hand are observers who have found radium to be most satisfactory in the treatment of carcinoma of the rectum.

Neuman and Coryn expressed the belief that the circumscribed mobile and operable carcinoma of the ampulla of the rectum comes within the exclusive province of surgical procedures, but that if carcinomas are inoperable, extensive, and fixed, their method of radiotherapy combined with operation is of considerable value.

Quick was optimistic with regard to the future of radium in the treatment of carcinoma of the rectum. He said: "We feel that we are making progress by the intensive use of radiation in this field of tumors, and that we are not only encouraged to proceed along these lines but that we are amply justified in so doing, since surgical technic alone, highly perfected as it is, obviously falls far short in caring for more than a relatively small percentage of the mass of rectal carcinomas at the time they come under treatment."

Kelly and Ward considered radium used alone or with some operative procedure as the most valuable therapeutic agent in the treatment of carcinoma of the rectum in all stages.

Cade laid down the following principles for the use of radium in operable cases in the light of the present stage of radiotherapy: (1) if operation is contraindicated on general grounds; (2) if the patient is made to understand that results are uncertain, and operation may be necessary after irradiation, and (3) to avoid colostomy in selected cases.

If the growth is inoperable, radium is indicated in every case, as palliative results are obtained in the majority of cases.

Our review of the literature on carcinoma of the rectum has led us to the following conclusions:

1. The vagueness of published reports and the variance of opinions make the literature unsatisfactory as a source of accurate information.

2. Radium is less satisfactory in the treatment of carcinoma of the rectum than it is in the treatment of adenocarcinoma of many other cavities of the body.

3. The problem in the treatment of carcinoma of the rectum by radium has been largely a matter of determining a suitable method of application so that the greatest possible exposure of the carcinomatous tissue can be obtained with the least possible injury to the sensitive mucosa of the rectum.

4. Few examples of undoubted cure from treatment by radium alone have been reported in the literature; however, in most cases there has been improvement in the patient's condition and relief of symptoms.

5. A combination of operation, radium and roentgen rays, with the surgical approach, has given satisfactory results in selected cases.

6. Radium and roentgen rays are undoubtedly indicated in cases of far advanced, inoperable malignant growths.

7. Whether treatment by radium and roentgen rays is to be preferred to operation in cases of operable carcinoma of the rectum is a debated point.

Results due to radium thus far have not been satisfactory. However, changes in technique and approach are made by radiologists from year to year and sufficient benefit is achieved to encourage continuance of effort.

Radiologists are not competing with sur-

geons in the treatment of these cases. Radiologists need all help possible from the surgeon. Any advance in the treatment of carcinoma of the rectum can only come through coöperation and coördination of the efforts of clinicians, surgeons, radiologists, proctologists, pathologists and patients.

A few cases are cited in which radium has proved of distinct benefit in our own experience.

CASE I. A man, aged sixty-eight, registered at the Clinic June 14, 1920, complaining of diarrhea and blood in the stools for the last year. For six weeks before admission, he had not been able to control his bowels. Proctoscopic examination disclosed a cauliflower-like growth on the anterior wall of the rectum just inside of and involving the sphincter muscle. The growth was about 4.5 cm. in diameter. Adenocarcinoma graded 2, was diagnosed from a specimen taken at biopsy.

The patient preferred treatment by radium to operation, and June 18, twenty glass seeds of 1.5 millicuries were implanted permanently throughout the growth, the dosage totalling 3,960 mc-hr. June 23 to 24, roentgen rays were applied to nine areas around the pelvis. The patient remained under the observation of his local physician. The growth disappeared entirely and remained healed for nine years. In the spring of 1929 rectal symptoms returned and recurrence was noted by his physician, who applied radium and roentgen rays. A report was received from the patient in the autumn of 1929. He had been benefited by radium treatment but still suffered from diarrhea and straining.

CASE II. A man, aged thirty-nine, came to the Clinic October 15, 1923, because of pain in the rectum for one year and bleeding for three months. The coccyx had been removed elsewhere one month previously because of pain. Proctoscopic examination disclosed a lesion 6 to 10 cm. in diameter just above the anus and involving the left wall of the rectum. A specimen taken at biopsy showed adenocarcinoma graded 1. Colostomy and resection was advised, but the patient refused operation.

Six hundred milligram-hours of radium were applied directly to the lesion and 1800 mg-hr. were applied three days later in the form of fifteen needles of 10 mg. (steel alloy wall 0.4 mm.) implanted into the tumor for twelve hours; 2400 mg-hr. were given. A course of high-voltage roentgen rays was also given.

Proctoscopic examination, May 5, 1924, did not reveal the original lesion. A stricture, 1 to 1.5 cm. in diameter at its narrowest point, replaced it 6 to 8 cm. above the anus. Proctoscopic examination, November 4, 1924, did not show evidence of malignancy.

The patient has been under observation every few months. Examination, October 21, 1929, did not reveal carcinoma; the patient was in the best of health and did not have any complaints.

CASE III. A man, aged fifty-two, registered at the Clinic December 29, 1923. He had noted slight bleeding and passage of mucus after defecation for the last year. Proctoscopic examination disclosed a lesion, about 4 cm. in diameter, on the left anterolateral wall of the rectum, at the level of the first valve.

January 3, 1924, 150 mg. of radium was given for twelve hours (1800 mg-hr.) with universal applicators placed along the median line of the growth. The rectum was packed with gauze. January 21, 100 mg. was given for six hours (600 mg-hr.).

Proctoscopic examination, January 17, showed gratifying disintegration of the lesion; only about a third of it remained. Proctoscopic examination, February 12, did not show evidence of carcinoma, but a large ulcer occupied the site of the former lesion. Perirectal induration reduced the lumen to 2 cm. April 8, the rectum was shown to be surrounded by a fixed pelvic mass and was obstructed down to 1 cm. Operation was advised.

Colostomy, April 12, did not show evidence of metastasis to the liver or lymph nodes. April 29, posterior resection (Kraske operation) was performed. It was necessary to open the peritoneum widely. The entire rectum and a small piece of the rectosigmoid was resected. Operation was difficult because of infection and previous treatment by radium.

The pathologist reported adenocarcinoma, graded 1, and necrotic ulceration with a large amount of fibrosis. A few carcinoma cells were found in the fibrotic tissue; none was found in the ulcer. Probably the carcinoma has been almost completely destroyed by radium.

The patient has been under observation at intervals. On his last visit, September 13, 1929, there was no evidence of malignancy. In De-

cember, 1929, he stated that he was in excellent health.

Case IV. A man, aged fifty-six, registered at the Clinic January 19, 1924, complaining of intermittent bleeding from the rectum for the last three or four years. A rectal polyp had been excised elsewhere in November, 1923, and had been diagnosed as nonmalignant. An unhealed ulcer remained at the seat of the operation. Six roentgen treatments had been given elsewhere, ending five weeks before admission. Proctoscopic examination showed a growth 5 to 6 cm. in diameter, on the left wall of the rectum just above the anus. Biopsy, January 21, showed adenocarcinoma, graded 3.

January 25, two applications of 100 mg. of radium were applied in the rectum, filtered through 1.5 mm. of monel metal, and rubber and held in place by a gauze pack. One treatment of seven hours and one of ten hours, a total of 1700 mg-hr. were given. Surface packs were also applied to the groins (8400 mc-hr.). February 8, another intrarectal application of 100 mg. was given for seven hours. February 25, roentgen rays of high voltage were applied to one area of the sacrum. April 7, proctoscopic examination showed that an ulcer 1 by 2 cm. replaced the original lesion. There was no evidence of malignancy or stricture. May 2, 100 mg. of radium was applied in the rectum, filtered with 1.5 mm. of monel metal and with rubber, for three hours.

The patient remained under observation of physicians at his home. The rectal lesion cleared up entirely. He returned to the Clinic August 30, 1929, because of ulcers on the skin in the sacral region, from roentgen-ray dermatitis. Proctoscopic examination showed a small scar at the site of the old lesion, but no activity.

Case V. A man, aged sixty-two, registered at the Clinic May 13, 1925. He had had a lump in the rectum for two months, with bleeding and serous discharge. Examination showed inoperable carcinoma of the anorectal area with probable metastasis to the right inguinal lymph nodes. Biopsy showed adenocarcinoma, graded 2.

May 16, fifteen 10 mg. steel alloy needles were implanted in the lesion for twelve hours, a total of 1800 mg-hr. The inguinal nodes received a total of 11,100 mg-hr. at a distance of 1 inch; fourteen areas were treated.

July 6, proctoscopic examination showed considerable slough involving the muscle but did not show evidence of malignancy in the rectum. The inguinal nodes were again treated. December 13, the rectum appeared to be normal except for a scar in the anus and low in the rectum. External irradiation and implantation was applied to the mass in the right inguinal region.

April 26, 1929, the rectum was clear. The right inguinal mass had decreased 30 to 50 per cent. Further radium packs were applied to the inguinal mass.

January 13, 1930, the home physician stated that there had not been a recurrence but that ulcers had developed on the right leg.

Case VI. A man, aged seventy-five, was examined June 29, 1925. He had noted pain and bleeding in the rectum for nine months. Proctoscopic examination showed a large inoperable carcinoma involving the middle third of the rectum in the posterior half. The lesion was adherent but was not obstructive. Biopsy showed adenocarcinoma, graded 2.

Treatment by radium followed coagulation of the central part of the tumor with surgical diathermy. Five applications of a tube of 50 mg. screened with 1 mm. of brass and 2 mm. of aluminum were given directly against the local lesion for a period of six hours each, a total of 1500 mg-hr. The inguinal lymph nodes were also packed, four areas each, with distance of 1 inch, a total of 5276 mg-hr. High-voltage roentgen rays were applied to five fields encircling the pelvis.

August 4, proctoscopic examination showed the carcinoma to be replaced by an ulcer 5 cm. long. Subsequent proctoscopic examinations, November 3, 1925, May 29, 1926, and November 9, 1926, did not show recurrence. The patient was examined at the Clinic in August, 1928, and carcinoma could not be found. In a letter dated March 11, 1930, he mentioned some prostatic trouble but stated that he did not have rectal symptoms.

Case VII. A man, aged sixty, came to the Clinic July 14, 1927, with a complaint of having had diarrhea for two and a half months. Proctoscopic examination showed a large, fixed carcinoma in the upper third of the rectum beginning 14 cm. above the anus. Obstruction would not permit the proctoscope to pass through the mass. Biopsy showed adenocarcinoma, graded 3.

July 21, colostomy was performed. Some enlarged nodes were found in the mesentery of the

sigmoid. A large tumor extended above the peritoneal fold and was fairly adherent in the sacrum but still movable.

August 9, 96 mc. of radium were placed in the rectum for six hours; the rays were filtered through 1 mm. of brass and 0.5 mm. of silver, on a long lead stem.

August 12, 56 mc. were applied for ten and three-fourths hours with the same filtration. August 16, 50 mg. were applied for fourteen hours; the rays were filtered through 1.5 mm. of monel metal, 2 mm. of lead, and 0.5 cm. of rubber, a total of 1178 mc-hr. and 700 mg-hr.

From August 18 to 23, 1927, high-voltage roentgen rays were applied to four fields.

October 21, proctoscopic examination showed a small slightly active area 18 cm. from the anus. The lumen was not diminished. The patient had gained 16 pounds. February 15, 1928, the original lesion had dissolved remarkably. Only a few small polyps remained and the colostomy opening could have been closed if the patient had desired. A letter, May 14, 1929, stated that there were no signs of the former trouble. The patient feels well, and has been gaining weight.

CONCLUSIONS

The data obtained from the literature and from our own files have guided us in the following conclusions:

1. We are of the opinion that cases of carcinoma of the rectum are surgical problems and that radium and roentgen rays are valuable surgical adjuncts.

2. The cases may be classified into operable and inoperable groups. Definite rules cannot be made regarding the method of classification; however, all cases of extensive local lesions, and wide fixation, with or without a serious break in the patient's general health, are placed in the inoperable group. In a limited number of cases in which the lesion is operable, an exploratory operation may reveal local or distant metastasis.

3. In a selected number of operable lesions a combination of operation, radium and roentgen rays should produce more lasting results than operation alone. In the event of preoperative preparation of the patient with adequate irradiation, the time interval between treatment and surgical removal should be at least eight weeks, or sufficiently long to permit satisfactory healing to have occurred in the treatment field.

4. The inoperable group furnishes many problems. It is possible in some cases to treat adequately without colostomy. In this event, the colostomy should be elective rather than emergent. Patients with extensive lesions should receive at least one course of adequate treatment; however, if the general health is sensibly undermined, only cautious treatment is indicated. There is a possibility that in certain cases the condition may be made operable by suitable treatment and a sufficient interval of time.

5. Palliation is all that should be expected in the presence of lesions in which malignancy is graded 4. Treatment by radium rays, supplemented with high-voltage roentgen rays, is the treatment of choice. Colostomy should be performed at an elective time.

6. For the present we should maintain a flexible method of treatment and thus individualize it as much as possible. Through coöperation and coördination of effort our present results should be greatly improved.*

* For discussion see page 657.

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A STUDY OF 210 CASES OF CARCINOMA OF THE RECTUM AND ANAL CANAL, TREATED BETWEEN 1914 AND 1925 INCLUSIVE*

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CARCINOMA of the rectum is a common disease which occurs at any age, from nineteen to eighty-seven years in our records (see Table 1). It comprises about 4 per cent of all the cases of malignant neoplasm admitted to the Institute.

TABLE I
Age Incidence at the time of Admission

Group	19	20–29	30–39	40–49	50–59	60–69	70–79	80–89	Total
I	—	—	1	5	7	5	4	2	24
II	1	5	6	30	38	45	16	2	143
III	—	—	3	2	9	19	9	1	43
Total	1	5	10	37	54	69	29	5	210

Of the 210 patients in this series, 121 were males, 89 were females; 17 of the patients were single and 193 married. A positive blood Wassermann reaction was recorded in only 9 cases. A history of cancer in the immediate family was reported in 48 cases.

A careful perusal of any statistics including a large number of cases must necessarily impress one with the relatively small number of cases that can be relieved surgically. The number of operative cases varies from 25 to 32 per cent. This leaves about 75 per cent of all the cases in which some other form of treatment must be carried out.

The operative mortality is estimated to be about 15 per cent. Taking the largest percentage of operable cases and considering the operative mortality, we have only about 5 cases in 100, or 5 per cent of all the cases of carcinoma of the rectum, in which there is any chance of a five year survival. Irradiation, which is possible in a very large percentage of the cases, may eradicate the disease or prolong life through its palliative effect. Seventeen per cent of all of our operable cases, treated with radiation, have remained well five years or more and 22 per cent have survived for five years or more. One and four-tenths per cent of all of the inoperable cases, those in which the tumor was fixed and had infiltrated the surrounding tissues, have remained well for five years or more. Of course, we realize that these figures are low but the treatment in this series of cases has been, to a large extent, inadequate.

The major responsibility for the unnecessarily high mortality rate in carcinoma of the rectum, lies with the general practitioner who sees the patient in the early stages of the disease, when a radical cure might be attempted. In most cases a definite diagnosis is possible by ordinary digital examination. The hard edge, the crater, are almost unmistakable. Yet our statistics, as well as those from other large clinics, show that persons afflicted with this disease apply for treatment relatively late. Although symptoms appear in its early stages they are usually treated as a benign condition for six months to a year or even longer. Our records show that the duration of symptoms, before applying for treatment, is from six months to two years. It is wrong to include alternating constipation and diarrhea, blood and mucus discharge, ribbon stools, and cachexia among the first symptoms. These are better forgotten. Over and over again one reads in the histories of an increasing frequency of evacuation; of a small movement, not loose, passed two or three times a day when such was not the habit; of an increased tendency to constipation when such was not the habit; of the occasional passage of a little blood with the stools, generally at-

* Read at the Fifteenth Annual Meeting, American Radium Society, Detroit, Mich., June 23-24, 1930.

tributed to hemorrhoids. In other words, a definite change of habit in the frequency and character of the stools.

The most common seat of the disease is from 2 to 4 inches from the anal ring. In only 20 of the cases in this series was the lesion located in the anal canal although this is the common seat of chronic inflammatory lesions such as piles and fistulae. In only a small percentage of the cases was the lesion above 4 inches in the rectum. About 42 per cent of the growths were annular, a few were horseshoe or nearly annular.

Ewing's[1] grouping of the pathology of carcinoma of the rectum, placed in order of frequency, is as follows:

1. Adenocarcinoma destruens—a broad ulceration with raised edges tending to encircle the bowel and leading ultimately to obstruction.
2. Stenosing fibrocarcinoma—a broad band of scirrhous type tending to obstruction as its early manifestation.
3. Gelatinous adenocarcinoma—a soft cellular growth, tending to early ulceration and bleeding.
4. Papillary carcinoma—a warty growth.
5. Multiple carcinoma following polyposis.
6. Epithelioma.
7. Melanoma.

One hundred eighty-one of our cases were biopsied; 152 showed adenocarcinoma; 15, epithelioma; 8, colloid carcinoma; 5, papillary adenocarcinoma; and 1, gelatinous carcinoma.

Except in the case of polypoid growths, there is no evidence to support the view that either hemorrhoids or fissures are precursors of cancer.

There is a wide variation in the degree of malignancy depending upon the tissue activities of the host and the growth character of the neoplasm. It is the general consensus of opinion among pathologists that carcinoma of the rectum is relatively benign; that the growth remains localized for a considerable period before extending by continuity to neighboring structures, or by metastasis to the regional lymph nodes. Exceptions may be found in cancer of the rectum in young persons. In these cases the growth invariably spreads rapidly and widely by metastasis.

The direction and method of spread outside of the rectum are also important factors in estimating the chances for removal. The spread anteriorly with fixation to the bladder and prostate precludes the possibility of surgical removal. The causes of numerous surgical failures are downward spread through the perineal skin, the ischiorectal fat and external sphincter ani; lateral spread through the levator ani, rectorectal lymph nodes, and lymph nodes in the region of branches of the internal iliac arteries; upward spread through the peritoneal fold to the pelvic mesocolon and paracolic lymph nodes and a group of glands situated on the left common iliac arteries.

TREATMENT

Prior to 1919 these cases were treated with 50 mg. of radium inserted against the lesion in the lumen of the strictured bowel, supplemented with low voltage roentgen rays. In 1919 and 1920, needles of 12.5 mg. of radium were inserted into the tumor mass, supplemented with low voltage roentgen rays. In 1921 the use of glass seeds of emanation was begun. These were introduced into the tumor mass and radium packs were applied externally. The pack factors at this time were: distance, 6 cm.; filter, 2 mm. brass, 1 mm. aluminum, and 1 cm. rubber; erythema dose, 6,000 to 8,000 mc-hr.; depth dose, 17 per cent at 10 cm. In 1922 the treatment was modified. Tumors which were situated in the lower 2 or 3 inches of the rectum and could be reached easily, were accurately planted with seeds of emanation, supplemented with high voltage roentgen rays. However, in treating tumors located high in the rectum, this method was found to be difficult on account of the danger of perforating the

[1] Ewing, James. Neoplastic Diseases. W. B. Saunders Co., Philadelphia, 1928, p. 711.

peritoneum. So they were treated by the insertion of tandem tubes of radium in the rectum for from 1,000 to 1,200 mc-hr. per tube, filtered through 0.5 mm. gold, 0.5 mm. brass, and 1 mm. rubber, supplemented with high voltage roentgen rays. The total dose approximated about 130 per cent, 3 to 5 cm. from the tubes. During 1922 and 1923 the roentgen radiation was given in one sitting; since then the dose has been divided over a period of a week to twelve days.

We now consider the treatment as described above as having been inadequate. It has, however, been an essential factor in developing a better technique.

Since 1926, we have treated all cases with gold emanation seeds supplemented with 10 cm. packs or heavily filtered high voltage roentgen rays. This we consider far superior to other methods used. Unfortunately, we are unable to consider any of these cases in our present report as no evaluation of any method can be given until five years have elapsed. We hope that with the use of gold filtered emanation seeds, together with more energetic external irradiation, our five year end-results will far surpass what has been accomplished hitherto. We hope that by educating the general practitioner, as well as the laity, to recognize all early symptoms as possibly dangerous, we will be able to secure a larger number of cases in the *early* stages. This will help considerably in coping with the malady successfully.

Surgery has been used only to relieve obstruction, either complete or threatening. In selected cases of cancer of the anal ring or tumors situated low in the rectum, causing much stenosis and pain, we resorted to electrocoagulation, completely destroying the anal ring and lower end of the rectum. This, we noticed, relieved the patients' suffering and improved their general condition, even though it left them incontinent. Two of these cases had colostomy in addition but we noticed no advantage in comparing them with those who did not.

GROUPING OF CASES

We have divided these cases into three groups:

Group I—All cases in which the disease was local and confined to the wall of the rectum or anal canal and was fairly movable.

Group II—All cases in which the disease had infiltrated the surrounding tissues and was fixed—mechanically inoperable.

Group III—All cases with widespread metastases such as metastases in the liver, mesenteric nodes, lymph nodes, or groins.

RESULTS OF TREATMENT

Group I: 24 cases.
- 1 case was unimproved and lost.
- 23 cases are available for study, of these:
  - 4, or 17 per cent, have been clinically well for 5 years or more.
  - 1 is alive 5 years after admission and is feeling well 4 years after last treatment.
  - 18 died from the disease:
    - 2 in from 3 to 4 years
    - 5 in from 2 to 3 years
    - 6 in from 1 to 2 years
    - 5 in less than a year.

Group II: 143 cases.
- 1 case was unimproved and lost.
- 4 died from intercurrent disease: 1 had been well for 3 years 4 months; 1, for 1 year 3 months; 1 had had palliation for 3 years; and 1 died one week after treatment, from shock following herniotomy performed elsewhere.
- 138 cases are available for study, of these:
  - 2, or 1.4 per cent, have been clinically well for 5 years or more.
  - 1 was well for 4 years when there was a recurrence. This patient is still alive 7 years after admission but has a mass filling the entire pelvis.
  - 135 died from the disease:
    - 9 in from 3 to 4 years
    - 11 in from 2 to 3 years
    - 43 in from 1 to 2 years
    - 72 in less than a year.

Group III: 43 cases.
- 1 died in 4 to 5 years; this patient had liver metastases when she was admitted. The tumor in the rectum disappeared for 3 years but recurred just before death.
- 1 died in from 3 to 4 years
- 9 died in from 2 to 3 years
- 10 died in from 1 to 2 years
- 22 died in less than a year.

In some of the annular growths which have healed, stricture is very marked, the lumen being not over 8 mm. Yet with a little care and regulation of the bowels with American oil and mild cathartics, these patients have been very comfortable.

CONCLUSIONS

1. In Group I cases, 17 per cent have been well five years or more.

2. In Group II cases, which were hopelessly inoperable, 2 cases, or 1.4 per cent, are well five years or more. Three cases have survived for five years or more. Of all of the Group II cases, 39 per cent have had palliations of from one to four years.

3. All the cases in Group III, those with disseminated metastases, died. Only a few of these had palliation.

DISCUSSION ON PAPERS OF BOWING, FRICKE AND HARPER, AND SCHREINER AND O'BRIEN.

Dr. Henry J. Ullmann, Santa Barbara, Calif. We are continually asked by our surgical friends, "What are you going to do with carcinoma of the rectum?" It has become a sore point, but we fortunately do not see many cases at Santa Barbara. The ones we see usually come late and the patients die. I would like to have some of our members who are also members of the College of Surgeons tell us what they think of radiation statistics compared with surgical statistics in operable cases. I am going home with the first real hope to offer my surgical friends, when we can say that we can relieve 17 per cent by radiation therapy, in operable cases. What can we do with a combination of therapies? I would like to hear this discussed by someone who can answer these questions, for carcinoma of the rectum is a very serious matter.

Dr. E. H. Skinner, Kansas City, Mo. Dr. Bowing should add to his list of favorably treated cases a case in which he cooperated with me in 1920. That patient had a lesion on the posterior wall which was an epithelioma upon biopsy. The treatment was given by putting small needles in a herring-bone pattern into the lesion, which was about 8 cm. long and 2 cm. broad. The needles were placed in position through a proctoscope followed by filtered capsules in a Wheatstone bougie. The patient made a complete recovery from this one treatment and has remained continuously well. I saw him two years ago and the clinical and proctoscopic examination showed no remnant of the lesion.

I have been somewhat impressed by the palliative treatment of the large ulcerating lesions just above the internal sphincter on the posterior wall. I have had a lesson on these in methods of treatment, and this also applies to the large ulcerative lesions in the vagina. Contrary to Dr. Bowing's report, I have not had such a favorable influence upon these by surface applications as I have by needling the base and margins of the ulcer. These lesions have not receded as I would expect them to from the amount of irradiation that was applied superficially in the table clinic shown by Dr. Loucks yesterday and described by Dr. Bowing. The patients who returned six to eight weeks after such treatment showed very little, if any, regression, but upon using the interstitial irradiation healing has taken place. These patients have continued to have function of the rectal sphincter. One patient remained well for three years and then died from metastasis to the liver. Three other patients are still living over periods of one to four years. These have all been patients of advanced age in whom nothing radical could be done and I feel that this palliative treatment has been very satisfactory.

Undoubtedly we all make a mistake in attempting to cure malignancy. The word "cure" should be eliminated. We should speak of the radium treatment of these cases not of cure. We do not secure cure in many of our problems in medicine, but the palliative care of these patients is possible and I think it is very satisfactory, even in lesions which have gone on to a point where colostomy is necessary. Those patients have a regression which is satisfactory, and I feel that my treatment of rectal malignancy has been much more satisfactory since I got away from the idea of curing them.

Dr. Isaac Levin, New York City. I wish to express my opinion in regard to the question our colleague asked regarding the treatment of operable cases. The difficulty in the treatment of carcinoma of the rectum with irradiation consists in the fact that the organ offers comparatively little protection against the reaction from irradiation. While carcinoma of the esophagus in this respect is the most difficult problem for radiotherapy, the rectum is nearly

as difficult. The same is true in malignancy of the larynx. Irradiation would give excellent results if it were not for the fact that intensive irradiation produces necrosis of the cartilage. I have treated a number of cases of carcinoma of the larynx with thyrotomy and insertion of radon, but my opinion to date is that laryngectomy offers the best chances in operable cases. The same is true of carcinoma of the rectum. I think there is no doubt that surgery is superior in operable cases. I use both radical surgery and irradiation. Radical removal of carcinoma of the lower sigmoid and rectum is a hazardous undertaking but the results, both immediate and final, are superior in selected cases to those obtained by radiotherapy. If the case is not absolutely operable, and that can be decided frequently only by laparotomy, then I believe that radiotherapy in carcinoma of the rectum if it is annular, should always be preceded by a colostomy. In the course of a colostomy I insert radon into the upper portion of the tumor and follow this with insertion of the peripheral part of the tumor through the anus. I have had good results in many cases with this technique. But until our methods of radiotherapy have improved considerably operable cases should be treated surgically.

Dr. Bowing (closing). At The Mayo Clinic the surgeons appreciate the possible good to be derived from a combination of surgery, radium and roentgen rays in the treatment of selected cases of carcinoma of the rectum. They prefer not to operate on lesions graded 4. In other words, for the present we have one definite type of carcinoma of the rectum. As a rule in cases of recurrence following surgical removal of the primary lesion, and in cases of grossly inoperable lesions, irradiation is given. The surgeons appreciate the fact that they need not assume an added risk in operating in a given case. I can only emphasize what Dr. Skinner has said, that it is our province to do everything we can for these patients to make them as comfortable as possible. If we do not accept this problem and give these patients all possible relief, they may seek treatment from less ethical sources with corresponding detriment to their condition. If these patients are not encouraged they will jump at any straw for relief. We prefer to advise the relatives rather than the patient in case of an ultimate poor prognosis, so as not to break the patient's morale.

I feel that our results so far are too meager to warrant a definite statement in regard to what can be expected from treatment in a given case, but from the few cases I have reported, and from others in our files not reported, I believe we can favorably influence rectal tumors. However, treatment must be limited because of the situation of the primary tumor, its size and extent of fixation, and so forth. Colostomy is a desirable procedure, but it carries a certain risk and is not necessary in all cases. The fact that we can approach sterilization of the field, in some cases completely, by the application of radium should be more generally known. Several years ago limited preoperative radium treatment was given in a series of cases and within a week or ten days posterior resection was done. This method of treatment was soon abandoned. The surgeons soon found that complications, such as edema, bleeding and postoperative infection, were more common in these cases. However, some of these patients could not return to the surgeon for one reason or another, so the operation was delayed many months and in some instances no evidence of malignancy was found when posterior resection was done. Biopsy was not done at the time the treatment was given but everything pointed to the diagnosis of carcinoma.

As I have said, as yet a definite recommendation cannot be made regarding the best method of treatment; however, evidence is at hand which shows clearly, provided preoperative irradiation is applied, that the treatment should be adequate and the time before operation sufficiently long to permit as much local healing as possible. The interval should be in terms of weeks and probably months.

Dr. O'Brien (closing). I think perhaps, to express Dr. Schreiner's viewpoint in carcinoma of the rectum, I should say that we do not do any surgery. Every one of our cases is treated by interstitial irradiation and energetic high power roentgen rays. We do not perform a colostomy, and see no advantage in doing so. The results of the most modern method of treatment, I am sure, will be that we will see a far superior percentage of clinically well patients at the end of five years.

In listening to Dr. Bowing's remarks regarding cases in which he was unable to palpate or see any evidence after irradiation of carcinoma of the rectum, I was reminded that I have palpated many cases of that nature where it was impossible to feel or see any scar tissue or tumor tissue after radium therapy supplemented with high power roentgen therapy.

THE RADIATION OUTPUT OF THE ROENTGEN TUBE AS DETERMINED BY THE TYPE OF APPARATUS*

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THE efficiency, η, of a roentgen tube is determined by the ratio of its output of radiation energy to the electrical energy supplied. Hence, if it is desired to determine the efficiency of a tube operated on various types of apparatus and compare the different values, the comparison must be made under conditions of equal energy output (in this case radiation energy) or of equal energy input. When the energy output of a tube on two different types of apparatus is held constant, then the ratio of the efficiency η_1 of apparatus 1 to η_2 that of apparatus 2 gives the rating of the tube, $b = \eta_2/\eta_1$, at which the tube operates on the two types of apparatus.

When, on the other hand, the energy input is held constant, then the ratio $Z = \eta_1/\eta_2$ represents the radiation output of the tube on the two types of apparatus.

Since the tube input is in the form of electrical energy and the output occurs as radiation energy, we must first review briefly the origin of the roentgen rays and their dependence on tube potential and current. When a high potential is applied to an electron tube (the old-fashioned ionization tubes are not under consideration here), the positive electrode, the anode, attracts the electrons clustered about the heating filament of the cathode. This attracting power increases with the applied potential; the speed of these electrons shooting upon the anode at a potential of about 78 kv. is 150,000 kilometers per second.[1] The impingement of these electrons on the anode gives rise, in addition to heat, to a continuous tube spectrum, the shortest wave length of which (in the region of the more penetrating radiations) is given precisely by the Planck-Einstein equation:

$$\lambda_0 = \frac{12.35}{\text{kv.}}$$

in Ångstrom units (1 Å = 0.1 mμ). Figure 1 shows the radiation intensities, I, as calculated by March[2] for different wave lengths

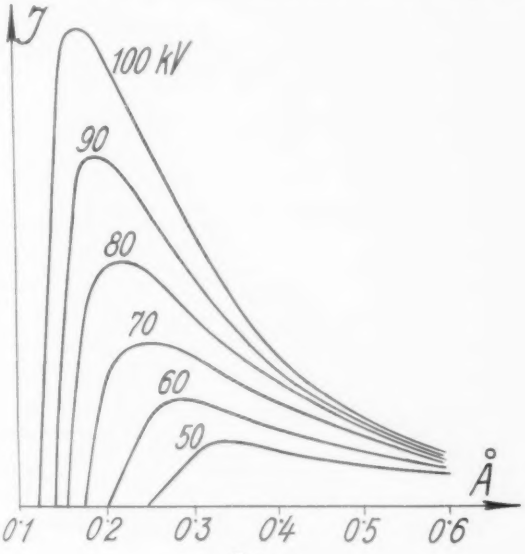

FIG. 1

and for various constant potentials applied to the tube. The intensities increase in proportion to the tube current strength. These curves, according to Dauvillier,[3] show a maximum for constant potential at a wave length, $\lambda_{max} = 1.304\lambda_0$. With sinusoidal potentials, the resulting spectrum will be a compound of the values corresponding to the potential at each instant in accordance with the above curves, and Dauvillier gives the equation, $\lambda_{max} = 1.304\,\lambda_0$ for the position of the maximum. Thus, the type of radiation differs depending on whether constant or varying voltage is used. Since, however, the determination of the rating, b, of the roentgen tube consists, as mentioned above,

* Translated from the German by Barnett Cohen, Ph.D., Johns Hopkins Medical School, Baltimore, Md.

in the comparison of the power inputs necessary to yield the same output of radiation, a requirement which is practically impossible to fulfill because of the differences in the spectra, it follows, therefore, that the determination of the radiation outputs, Z, i.e., the comparison of radiations under equal conditions of electrical input, is more promising for a solution of our problem. Besides, it is always possible to determine the tube rating, since a tube which yields more radiation with one type of apparatus has a relatively lower rating.

In order, therefore, to determine the radiation output of a tube with different types of transformers, we must establish under what conditions two roentgen machines deliver the same power to the tube.[4]

I. OUTFITS GIVING SINUSOIDAL VOLTAGE

(*a*) *The Half-Wave Outfit.* The electron tube operates directly from the transformer and acts as a rectifier; therefore current can flow through the tube only during a half-period. Figure 2 shows the variation in potential. The current curve depends on the characteristics of the tube (variation of current with potential). To eliminate this factor, we shall assume in this discussion, first, that we have a tube whose current, with proper polarity, increases proportionally with the voltage (tube with constant internal resistance) and second, that we have a tube operating at full load on all voltages (tube with constant current strength).

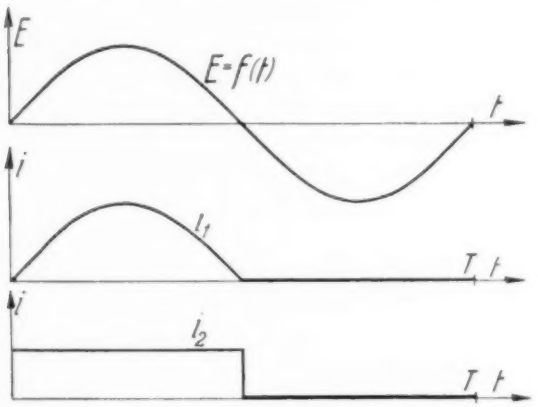

FIG. 2

The actual characteristic must lie somewhere between the two assumed conditions, hence this source of error will be eliminated from our discussion.

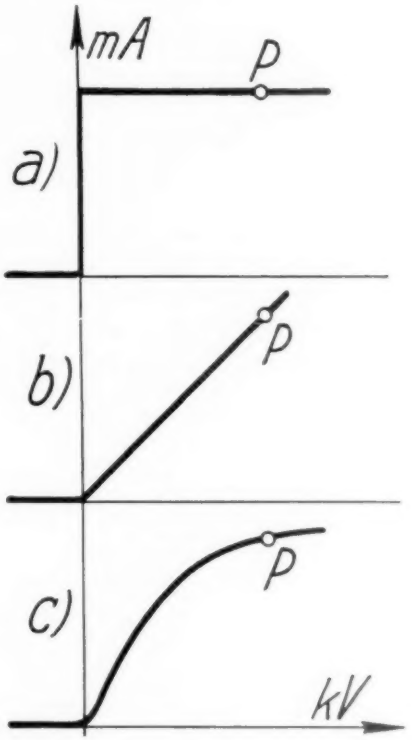

FIG. 3

Figure 3 shows different characteristics of roentgen tubes. Curve *a*) shows the ideal characteristic for full saturation; curve *b*) shows the limiting characteristic for a tube with constant internal resistance. When a roentgen tube of any given characteristic is operated at a maximum load P, its characteristic will practically always be found to lie (see curve *c*) between the above indicated limiting values. The current curves corresponding to these limiting conditions are shown in Figure 2: the middle curve represents the condition for a tube with constant internal resistance, and the lower curve for a tube at full saturation.

The electrical power used by the tube is described by the general equation

$$N = \frac{1}{T}\int^{T} E_t i_t dt.$$

The potential is best measured by means of the spark-gap, the current is generally measured with a moving coil milliammeter which indicates the algebraic mean:

$$i_0 = \frac{1}{T}\int^{T} i_t dt$$

of the current curve.

If we measure, by means of the spark gap, the peak potential of various potential curves and, by means of the direct current milliammeter, the average of the corresponding current curves, it is necessary to apply a correction factor in order to obtain the true output at constant applied peak potential and constant milliammeter reading. This factor is:

$$c = \frac{N}{E_{max} i_0} = \frac{\frac{1}{T}\int^{T} E_t i_t dt}{E_{max}\frac{1}{T}\int^{T} i_t dt}$$

Then, for the half-wave apparatus, we have

$$c_1 = \frac{\frac{1}{T}\int^{T/2} E_{max}\sin\omega t\, i_{max}\sin\omega t dt}{E_{max}\frac{1}{T}\int^{T/2} i_{max}\sin\omega t dt} = \frac{\pi}{4} = 0.785$$

for the tube of constant resistance, and

$$c_2 = \frac{\frac{1}{T}\int E_{max}\sin\omega t\, i_{max}\, dt}{E_{max}\quad \frac{i_{max}}{2}} = \frac{2}{\pi} = 0.637$$

for the completely saturated tube.

(*b*) *Four Electron-Valve Apparatus.* In the Grätz circuit four electron tubes are arranged at the high tension pole of the transformer in such a manner that a rectified sinusoidal potential reaches the tube during each half-wave. The time relations of the potential curve and of the current curves due to potential and limiting characteristics are shown in Figure 4.

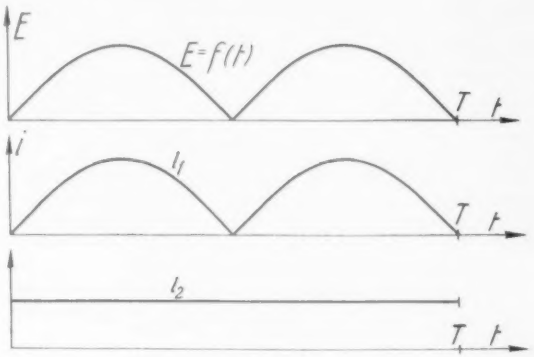

Fig. 4

The correction factor is calculated like that for the half-wave outfit,

$$c_1 = \frac{\pi}{4} = 0.785$$

for the tube with constant internal resistance and

$$c_2 = \frac{2}{\pi} = 0.637$$

for the fully loaded tube.

II. Outfits with Mechanical Rectification and Fluctuating Direct Voltage

(*a*) *Apparatus with Rotating Needle Interrupter.* In this type of interrupter, the sinusoidal potential delivered by the transformer is interrupted by contacts (needles)

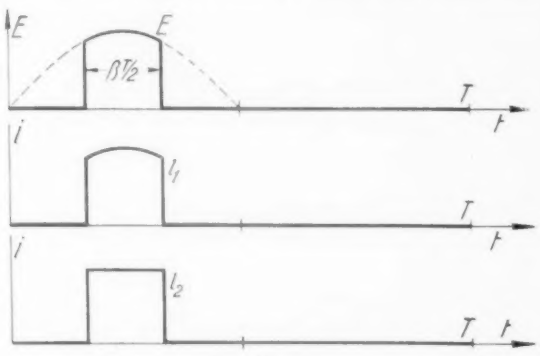

Fig. 5

actuated by a synchronous motor in such a manner that only the positive half-wave of potential reaches the tube, and contact is maintained only for the period of maxi-

mum voltage. The voltage curve corresponds to a sinusoidal potential functioning during the period $\beta T/2$, and accordingly the current curves for the ideal tube characteristics are those shown in Figure 5.

In this case, the correction factor applicable is:

$$c_1 = \frac{\frac{1}{T}\int_{(1-\beta)T/4}^{(1+\beta)T/4} E_{max} \sin \omega t \, i_{max} \sin \omega t dt}{E_{max}\frac{1}{T}\int_{(1-\beta)T/4}^{(1+\beta)T/4} i_{max} \sin \omega t dt}$$

$$= \frac{1}{2}\left(\cos\beta\frac{\pi}{2} + \frac{\beta\frac{\pi}{2}}{\sin\beta\frac{\pi}{2}}\right)$$

for the tube with constant resistance, and

$$c_2 = \frac{\frac{1}{T}\int_{(1-\beta)T/4}^{(1+\beta)T/4} E_{max} \sin \omega t \, i_{max} dt}{E_{max}\frac{\beta i_{max}}{2}}$$

$$= \frac{\sin\beta\frac{\pi}{2}}{\beta\frac{\pi}{2}}$$

for the tube with constant current strength.

(For the sake of simplification, these functions are evaluated in terms of β in Figure 9 at the end of the discussion of apparatus.) When $\beta = 1$ the cut off sinusoidal potential equals a full half-wave, and the apparatus will show no difference from the half-wave apparatus (Ia). Under practical conditions the maximum value for β is 0.4.

(*b*) *Apparatus with Rotating Rectifier.* Whereas the needle interrupter delivers to the tube only one half-wave of the current, the synchronously driven rectifier automatically reverses the alternating negative phases so that a rectified peak potential reaches the tube during each half-period. The variation of potential with time in this apparatus and the current-curves for the fundamental tube characteristics are shown in Figure 6.

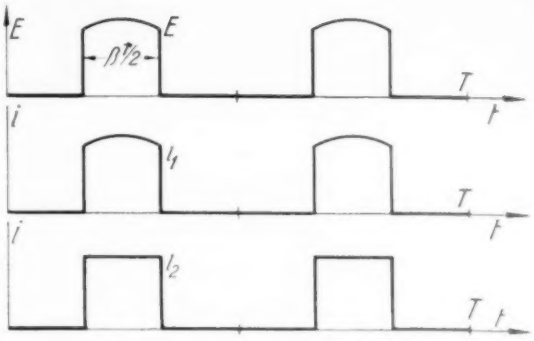

FIG. 6

The values for the correction factor, c, as determined by β, the fraction of the half-period during which the voltage is applied to the tube, are given by

$$c_1 = \frac{1}{2}\left(\cos\beta\frac{\pi}{2} + \frac{\beta\frac{\pi}{2}}{\sin\beta\frac{\pi}{2}}\right)$$

for the unsaturated tube, and

$$c_2 = \frac{\sin\beta\frac{\pi}{2}}{\beta\frac{\pi}{2}}$$

for the fully loaded tube. In this case, c_1 and c_2 have the same values as for the needle interrupter.

It will be observed that the correction factor does not change from half-period to whole-period operation (needle interrupter, half-wave apparatus vs. mechanical rectifier, four electron-tube apparatus) but that it is dependent first on β, the duration of contact referred to the half-period, and second on the degree of loading of the tube.

(*c*) *Multiphase Current Outfits.*[5] In the Grätz circuit six electron-tubes are connected to three binding posts of the secondary of the high-tension transformer so that the anode and cathode of the tube are supplied with the same polarity at all times.

The voltage curve and the corresponding current curves are shown in Figure 7. The

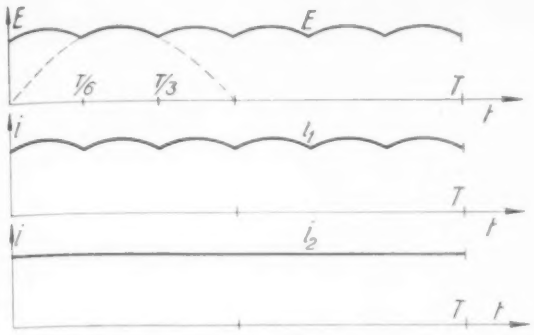

FIG. 7

voltage curve is a succession of symmetrical portions of the summits of the sine curve lying between $n\ T/6$ and $(n-1)T/6$ (the peak value equals twice the peak potential of any phase). The general equation for the calculation of the correction factor is applicable in this case if $\beta = 1/3$ and $T/6$ is used. The values thus calculated are: $c_1 = 0.956$ and $c_2 = 0.955$ corresponding to the limiting tube characteristics above specified.

III. THE CONSTANT VOLTAGE APPARATUS

In the Greinacher circuit, two condensers are charged alternately during each half-period by the high voltage from the transformer and these, discharged in series, give the constant potential required at the tube. As shown in Figure 8, the current requirement in this case is independent of the

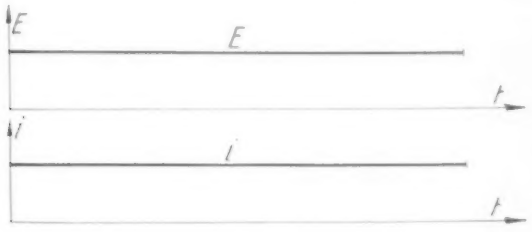

FIG. 8

characteristics at all levels between the origin and the operating load; the level of the operating load alone determines the current requirement.

It is evident, therefore, that the correction factor must be

$$c = \frac{Ei_0}{Ei_0} = 1.$$

In Figure 9 are shown the values of the correction factor in relation to β (the relative duration of contact) for the saturation conditions of the tube. It will be seen that with equal peak potentials and milliammeter readings, a roentgen tube will have the highest rating ($c = 1$) on the constant potential apparatus and the lowest on outfits with sinusoidal voltage (half-wave apparatus, four electron-tube apparatus) with values between 0.637 and 0.785 depending on the tube characteristic. A consideration of these two limiting cases will suffice.

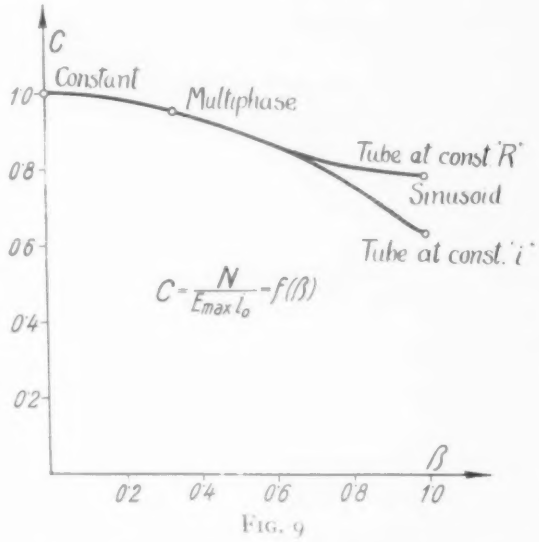

FIG. 9

In order to obtain equal tube loading, which is necessary for a comparison of radiation outputs from different apparatus, either the current or the voltage must be increased by $1/c$. Therefore the operating conditions will be as follows:

		Tube Potential (peak value)	Milliamperes (moving coil instrument)
I. Constant voltage		E	i_0
II. Sinusoidal voltage			
1. Tube with constant resistance	a_1	E	$\frac{i_0}{0.785}$
or	b_1	$\frac{E}{0.785}$	i_0

2. Tube with constant current	a_2	E	$\frac{i_0}{0.637}$
or	b_2	$\frac{E}{0.637}$	i_0

Therefore, to compare the energy outputs on two different types of apparatus, the radiations must be compared on this basis. For this purpose, a calculation was made of the spectral intensity distributions at $E=60$ kv. for the above indicated operating conditions (2) for both constant and sinusoidal voltage. In the latter case, the sine curve area was integrated by the well-known method of summating strips of equal width and varying height as is done, for example, for field computations. Figure 10 shows the radiation intensities I_λ as a function of the wave-length for the five operating conditions indicated in the table.

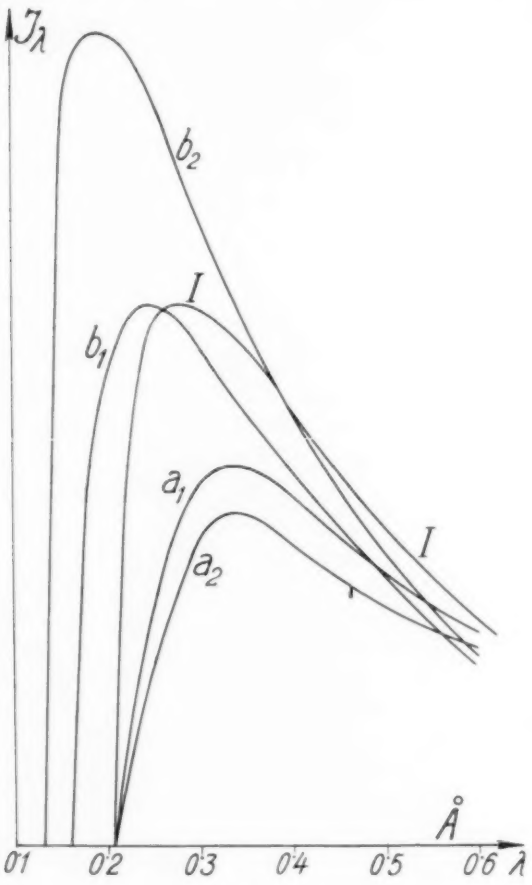

FIG. 10

Comparing the constant potential curve I with curves a_1 and a_2, it is apparent that the roentgen tube carries the lower load when operated on sinusoidal apparatus running at the same peak potential and milliammeter reading. The difference can be eliminated by

(*a*) increase of the tube current. This brings us to curves a_1 and a_2 between which is located the true spectrum. The wave-length of its intensity maximum, which equals approximately two-thirds that from constant potential operation, lies in the region of soft radiation. The relative proportion of soft radiation is greater than that from constant potential.

(*b*) increase of tube voltage. In a tube of constant internal resistance we obtain an intensity distribution curve b_1 similar to that in the constant potential spectrum; however, there occurs a shift of the whole spectrum toward the short-wave region to the extent of $(1-0.785)\,\lambda_0$. The intensity maxima are of equal magnitude and the proportion of soft radiation is less. In a tube with constant current strength, the spectrum, b_2, and the wave-length of its maximum are shifted toward the region of more penetrating radiation. The limiting wave-length drops to 0.637 of the value for constant potential, and the intensity maximum rises to a value about one and one-half times as great.

It should be noted that the formula of Dauvillier for sinusoidal potential

$$\lambda_{max} = 1.304\lambda_0 + 0.05\text{Å}, \quad \text{for} \quad \lambda_0 < 0.30\text{Å},$$

applies to operation on constant current. However, in the case of sinusoidal current, which is the basis for the calculations of curves a_1 and b_1, the wave-length of the intensity maximum is shifted somewhat toward the short wave region.

CONCLUSIONS

In order to obtain the maximum possible radiation from a roentgen tube under a

given load, the lower rating of the tube when operated on sinusoidal apparatus (half-wave apparatus or four electron-valve outfit) should not be compensated for by increase in current strength but by increase in tube voltage. Depending on tube saturation, this increase should be from 1.27 to 1.57 times the constant-voltage equivalent, provided the tube can stand this without danger of breakdown. Diagnostic tubes may be used up to 110 kv. max.; therapy and material-testing tubes may be used up to 200 kv. max. This always yields harder radiation with a smaller proportion of soft rays than is given by constant voltage. The intensity maximum of such radiations from the fully saturated tube, which is the desired ideal because of the totally independent regulation of tube current and voltage, rises about 1.5 times above that from the constant voltage tube. Moreover, since slight gas discharges in the roentgen tube on sinusoidal apparatus do not so seriously affect the life of the tube as is the case on constant-potential outfits(the voltage drops in sinusoidal apparatus are smaller than those in outfits with rotating rectifier), apparatus with sinusoidal potential possess a considerable advantage under constant operation (roentgenoscopy and therapy) over the other types. In addition, there is, as already mentioned, the advantage of a smaller proportion of soft radiation in the spectrum upon making the required voltage increase while maintaining constant tube load. The same is true for short-period operation with high load, but here the time distribution of the load on the focal spot plays a more important role. In this case, the half-wave apparatus is the choice for small and medium loads, and the four electron-tube outfit for large and extreme loads.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Publisher: Charles C. Thomas, Springfield, Ill.

Issued Monthly. Subscription $10.00 per year, $11.00 in Canada and $12.00 in foreign countries. Advertising rates submitted on application. Editorial office, 110 Professional Building, Detroit, Mich. Office of publication, 220 E. Monroe St., Springfield. Ill. Information of interest to all readers will be found on page iv.

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Antoine Béclère
President, Third International Congress of Radiology

EDITORIAL

DR. ANTOINE BÉCLÈRE

PRESIDENT OF THE THIRD INTERNATIONAL CONGRESS OF RADIOLOGY

DEAN of French radiologists, Dr. Antoine Béclère has come to occupy a warm spot in the heart of every American physician who has had the privilege of his acquaintance. It has been the good fortune of many of us to come in close contact with this genial and delightful personality and to have profited greatly by his instruction, his great fund of experience and his exemplary and inspiring application to his chosen field while at the same time maintaining his advanced position as a physician.

In 1893 Dr. Béclère graduated with the title "Physician of the Hospitals of Paris." At first he interested himself in pediatrics, in the course of which he carried out long and interesting experimental investigations on immunity by vaccination.

In 1896, very much interested in Roentgen's discovery, he appreciated at once the alluring future offered by this new method of examination. In 1897 he commenced the study of medical diagnostic radiology in his general medical service at the Tenon Hospital; here at first, later at the Hospital St. Antoine, for twenty-three years he practised and taught diagnostic and therapeutic radiology.

In 1908 he was made a member of the Academy of Medicine, and in 1911 a Chevalier of the Legion of Honor.

At the outbreak of the World War, in spite of the fact that his age excused him from all military obligation, he placed himself at the disposition of the Medical Department of the Army. As Mèdecin Major of the first class, he was Chief of the Laboratory of Radiology of the Val de Grâce Military Hospital. Further, he was appointed Chief of the Central Service of Radiology of the military government of Paris, and in this capacity he organized, directed and inspected the hundred or more radiological laboratories which were established in the Paris area.

In 1918, at the close of the war, he was made an officer of the Legion of Honor because of his distinguished military service.

Scores of officers in the radiological service of the United States Army had occasion to meet this renowned radiologist in connection with the school of instruction carried on in Paris or while in attendance at the Val de Grâce clinics.

On returning to civil life after the war, Dr. Béclère became a member of the executive committee of the Curie Foundation of the Radium Institute of the University of Paris.

In 1927, as a final recognition of the achievements of this brilliant physician, he was elected President of the Academy of Medicine.

From the radiological point of view, Dr. Béclère was one of the pioneers of radiology in France, and founder and first president of the Société de Radiologie, and one of the founders of the *Journal de Radiologie*. For thirty years he conducted a free educational center in radiology attended by practically all French radiologists and a very large number of foreign workers in this field.

Among his most important publications are the following:

1. His radiotherapeutic technique in tumors of the hypophysis, with the first known case of lasting cure.

2. His work on the radiotherapy of seminomas (testicular tumors) and their metas-

tases. He was the first to demonstrate the extraordinary radiosensitivity of these tumors and the excellent results obtainable by radiotherapy.

3. Investigation on the radiotherapy of uterine fibromyomas, with more than 1500 treated cases.

4. From the radiotherapeutic viewpoint, it is interesting to note that he was always opposed to the German doctrine of the single maximum dose in the minimum of time. He always maintained the advisability of fractional doses, spread out over a more or less prolonged period, and more or less intense, according to the radiosensitivity of the tissues under treatment. Later developments in radiotherapy have shown the wisdom of his stand, and even in Germany everybody has abandoned the single maximum dose in the minimum of time.

Furthermore, Dr. Béclère has always doubted the existence of a stimulating effect from small doses of radiation.

In the Third International Congress of Radiology to be held in Paris from July 27 to 31 of this year we shall all deem it a privilege to renew and express the warm affection and esteem we hold for this outstanding pioneer and master of radiology.

James T. Case

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. John T. Murphy, 421 Michigan St., Toledo, Ohio.
Thirty-second annual meeting: Haddon Hall, Atlantic City, N. J., Sept. 22-25, 1931.

American College of Radiology
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual Meeting: Philadelphia, 1931.

Section on Radiology, American Medical Association
Secretary, Dr. G. W. Grier, Jenkins Arcade, Pittsburgh, Pa.
Annual meeting: Philadelphia, June 8–12, 1931.

Radiological Society of North America
Secretary, Dr. I. S. Trostler, 812 Marshall Field Annex, Chicago, Ill.
Seventeenth annual session: Hotel Jefferson, St. Louis, Mo., Nov. 30–Dec. 4, 1931.

Radiological Section, Los Angeles County Medical Society
Secretary, Dr. John F. Chapman, 209 Professional Bldg., Pasadena, Calif.
Meets on the third Wednesday of each month at the California Hospital.

Radiological Section, Southern Medical Association
Secretary, Dr. W. S. Lawrence, Medical Arts Bldg., Memphis, Tenn.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Masterson, 401-76th St., Brooklyn, N.Y.
Meets monthly on the first Tuesday from October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

Chicago Roentgen Society
Secretary, Dr. George M. Landau, 660 Groveland Park.
Meeting second Thursday of each month October to May inclusive at Virginia Hotel.

Cleveland Radiological Society
Secretary, Dr. A. Srauss, 518 Medical Arts Bldg.
Meetings are held at 6:15 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Central Illinois Radiological Society
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

Milwaukee Roentgen Ray Society
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee.
Meets first Friday in October, December, February and April.
Place of meeting designated by the president.

Minnesota Radiological Society
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.
Next meeting: Minneapolis, May 4, 1931.

New England Roentgen Ray Society
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

New York Roentgen Society
Secretary, Dr. J. Bennett Edwards, Englewood Hospital, Englewood, N. J.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

Central New York Roentgen Ray Society
Secretary, Dr. Robert C. Hall, 258 Genesee St., Utica, N.Y.
Three meetings a year—January, May and November.

Pennsylvania Radiological Society
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Next meeting, Penn. McKee Hotel, McKeesport, Pa., May 13–14, 1931.

Philadelphia Roentgen Ray Society
Secretary, Dr. Karl Kornblum, 3400 Spruce St.
Meeting first Thursday of each month from October to May inclusive, at 8:15 p.m., in Thomson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Camp C. Thomas, 476 Lake Ave.
Meets monthly on the first Friday evening at 7:45 at the Rochester Medical Association Building.

St. Louis Roentgen Club
Secretary-Treasurer, Dr. E. W. Spinzig, 316 Metropolitan Bldg.
Meets first week of each month. Time and place of meetings designated by president.

Texas Radiological Society
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Roentgen Ray Society
Secretary, Dr. B. D. Harrington, University Hospital, Ann Arbor, Mich.
Meets every Wednesday evening from October to June, at 7:30 o'clock in the amphitheatre of the University Hospital.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

VIRGINIA ROENTGEN RAY CLUB
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.
Next meeting, to be announced.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA
Secretary, Dr. Francisco Padron, Enrique Villuendas 64, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIETE DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE.
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SÜD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE ROENTGENGESELLSCHAFT
Meets annualy in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Nicolae Busila, 44 Elizabeta Blvd., Bucarest.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets first Tuesday each month, October to July.

ORIENT

JAPAN X-RAY ASSOCIATION
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.
Next meeting to be held April 1, 1931.

KINKI ROENTGEN-ABEND SOCIETY
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto, Japan. Meets bi-monthly on third Sunday.

PROGRAM

AMERICAN RADIUM SOCIETY

THE Sixteenth Annual Meeting of the American Radium Society will be held Monday and Tuesday, June 8 and 9, 1931, at Philadelphia, Pennsylvania. The headquarters and place of meeting will be at the Hotel Adelphia. The following program has been arranged by Dr. Sanford Withers, the president-elect of the Society and chairman of the Program Committee:

MONDAY, JUNE 8, 1931

Morning Session

9:15 A.M. EXECUTIVE BUSINESS MEETING
10:15 A.M. SCIENTIFIC SESSION

ADDRESS OF PRESIDENT

HENRY JOHNSON ULLMANN, M.D.,
Santa Barbara, Calif.

SYMPOSIUM ON THE BIOLOGICAL EFFECTS OF RADIUM RADIATIONS

From the Memorial Hospital, New York
HAYES E. MARTIN, M.D., *Chairman*

1. THE SKIN ERYTHEMA REACTION AS PRODUCED BY RADIUM RADIATIONS

GEORGE T. PACK, M.D.

The threshold skin erythema reaction as used at Memorial Hospital is defined. The degree of this biological reaction is not uniform in all clinics and various conceptions are discussed. The intensity and time interval of irradiation as affecting the degree of skin reaction are discussed, as well as the effect of a combination of gamma and x-rays. A knowledge of the skin erythema dose of each external applicator is of great value in outlining therapeutic doses. The behavior of the skin, both immediate and remote, following single and multiple skin erythema doses is described.

DISCUSSION OPENED BY DR. EUGENE PENDERGRASS, PHILADELPHIA.

2. THE RELATION OF INTENSITY OF RADIUM RADIATIONS TO TISSUE REACTION USING A SEGMENT OF A GROWING MOUSE TAIL AS A BIOLOGICAL INDICATOR.

HALSEY J. BAGG, Ph.D., AND
C. ROBERT HALTER, M.A.

The work described in this paper is concerned with a study of the effect of varying the intensity of radon radiation in relation to the biological reaction. All other conditions remaining the same, an attempt has been made to determine if there is an appreciable difference in reaction between a relatively strong dose delivered within a comparatively short period as compared with the same dose given over a much longer time. The treatments have varied from a few seconds to several hours.

Over 125 animals have been treated in pairs, with either the unfiltered, mainly beta-ray radiation, or through 2 mm. of brass, or by means of the platinum-gold tube.

DISCUSSION OPENED BY DR. DOUGLAS P. MURPHY, PHILADELPHIA.

3. THE RELATIVE BIOLOGICAL EFFECTIVENESS OF X-RAYS AND GAMMA RAYS.

G. FAILLA, D.Sc., AND P. S. HENSHAW, Ph.D.

Both x-rays and gamma rays are capable of producing certain biological effects. The relative amounts required to produce the same effect in a given medium depend first of all on the way in which quantity of radiation (usually called "dose") is defined and measured. The international unit of X-radiation, *the roentgen*, adopted in 1928, is based on ionization in free air. Theoretically it is obvious that the roentgen can be used also as a unit of gamma radiation. The experimental procedure, however, is fraught with many difficulties, which have now been overcome. The method for measuring gamma radiation in roentgens will be described.

Having thus measured x-rays and gamma rays in the same unit, it became possible to measure the biological effectiveness of these two widely differing qualities of radiation. Wheat seedlings and *Drosophila* eggs were used as test objects. The former presents four tissues that are biologically measurable and the latter, one; each of which has a different radiosensitivity. Linear growth was measured in the seedlings and per cent survival in the eggs. It was found that tissues respond differently to the two types of radiation and for producing certain biological effects, the gamma rays were found to be three to four times as effective as filtered x-rays per roentgen of radiation.

DISCUSSION OPENED BY DR. F. C. WOOD, NEW YORK.

4. THE DIVERGENCES BETWEEN ANTICIPATED AND OBSERVED RESULTS OF IRRADIATION OF PATHOLOGICAL TISSUES.

FRED W. STEWART, M.D.

Conclusions drawn from studies of the effects of irradiation on normal tissues are of but limited value in estimating the effects to be realized on pathological tissues. Individuals with pathological processes often show general abnormalities in addition to the

local disease—disturbances in metabolism, anemia, toxemia, diminished renal output, cardiovascular difficulties, localized infections and the like. Deductions drawn from the behavior of a certain tumor type in one location do not necessarily apply to the same histological type in another location.

Even if we were to take into consideration every possible ascertainable factor in a given case we would still encounter discrepancies between the expected and the obtained result. This however should not tend to discourage the investigator. It should rather encourage him to insist upon as accurate knowledge as possible of the whole physical status of the individual patient, his age, circulatory status, nutrition, blood picture, general vigor and renal condition, the intimate description of the tumor to be treated, its growth character, papillary features, infiltrative peculiarities, accurate size, location, rate of growth, ulceration, type of infecting flora, histological peculiarities, blood supply and cellular reactive phenomena.

The radiation must be measured, the time of onset, duration and character of its effect accurately noted. When all these data are available in a large group of tumors one will have done everything possible toward securing a basis for the estimation of the expected radiation effects.

Discussion to be Opened by Dr. Douglas Quick, New York.

5. The Grouping of Radium Tubes in Packs or Plaques to Produce the Desired Distribution of Radiation.

Edith H. Quimby, M.A.

The purpose of the work presented in this paper is to make possible the most efficient use of various quantities of radium in external applicators. Since radium is used in tubes and needles of various sizes, and it may be necessary to group an assortment of them in an applicator, a study is first made of the distribution of radiation around tubes of different lengths, from 1 to 6 cm. With an external applicator, it is, in general, desirable to deliver on the skin area under it a radiation as nearly uniform as possible. For certain combinations of tubes in certain applicators the skin radiation delivered by various arrangements is investigated and some conclusions drawn as to general considerations to be followed in placing any given set of tubes in a specific applicator. A method is developed whereby the actual radiation distribution in any instance can be determined, with the aid of the data included in this paper.

Discussion to be Opened by J. L. Weatherwax, Philadelphia.

Monday Afternoon Session

2:00 P.M. Executive Business Session

2:15 P.M. Scientific Session

Symposium on Intra-Oral Cancer

Douglas Quick, M.B. (Tor.), *Chairman*

Attending Surgeon, Memorial Hospital, New York

1. Grade of Malignancy and Radiosensitivity in Intra-Oral Cancer: Their Influence on Clinical Procedure. The Lack of Satisfactory Correlation Between Anticipated and Observed Irradiation Effects.

Fred W. Stewart, M.D., New York City

Tumor grading in intra-oral lesions just as in tumors of other locations is of particular value as applied to a group of patients rather than to an individual. In the individual, size, location and extent as judged clinically are, as a rule, of more importance than grade. In other words, in the individual, grading does not by any means indicate the clinical course to be anticipated but may well assist in so doing, providing all accessory factors such as location, size and extent, together with the general status of the patient are taken into consideration.

The impression given by the pathologist of grade of malignancy and radiosensitivity must be tempered by clinical judgment and clinical experience and is useful to the clinician treating intra-oral cancer only so long as he understands the pathologist's limitations, and does not allow his clinical judgment to be too lightly set aside by laboratory data. On the other hand, in the extremes of radiosensitivity and malignancy as determined by the laboratory, the mode of treatment selected by the clinician may be greatly influenced by the laboratory findings and either curative or palliative efforts moulded to the clinical-pathological setting of the individual patient.

2. The Treatment of Malignant Lesions of the Mouth by Contact Applications of Radium.

G. W. Grier, M.D., Pittsburgh, Pa.

Where the location of the lesion allows accurate adjustment, the author believes that contact applications of radium are superior to other methods of radiation therapy. The greater filtration possible in this technique supplies a larger percentage of gamma radiation, which has a more beneficial effect on the malignant tissue with less sloughing of normal tissues. Interstitial radiation increases the danger of secondary infection which adds to the sloughing and to the patient's toxemia. The added traumatism in this method also increases the danger of inducing metastasis by the treatment. Details of various methods and appliances for placing and holding the radium in accurate contact with the lesion in different locations in the mouth will be described.

3. Radium Treatments of Intra-Oral Cancer (With Heavy Filtrations).

Bernard P. Widmann, M.D., Philadelphia, Pa.

A detailed account of an experience of three years with filtrations equivalent to 2 mm. of platinum is submitted. Lead filters with densities equivalent to 2.5 times greater than the equivalent to 2 mm. of brass have been used almost routinely. All intra-oral lesions are treated with "surface" or "contact" applicators—but these are supplemented with interstitial radiation when the primary lesion is not too extensive. Generally interstitial radiation supplements all "contact" applications particularly for the technically operable lesions. Heavily filtered "contact" applications have demonstrated the possibilities of administering massive total doses of radiation throughout the oral cavity with very uniform distributions, so that 5 to 8 erythema doses have been administered through the center of the tongue. Special reference will be made to a detailed account of the technical procedures and criteria that have determined the type of treatment for various lesions—according to the extent and anatomical site of involvements. Advantages and limitations and comparative estimates with other technical procedures are briefly summarized.

4. The Use of Gold Filtered Implants in the Treatment of Intra-Oral Cancer.

Hayes E. Martin, M.D., and George S. Sharp, M.D., New York City

Successful radiation therapy of intra-oral cancer requires the use of some form of interstitial irradiation in a large percentage of cases.

The average intra-oral growth is comparatively radioresistant and its lethal radiation dose is greater than the maximum tissue dose, which can be safely delivered by external irradiation alone.

Provided that the radiant energy is delivered to all parts of a given tumor mass in accordance with what physical investigations have shown to be the most efficient manner, satisfactory results should follow the use of either needles or seeds. There may be definite indications for the use of one or the other in the individual case, but we believe that the gold filtered implant is the most generally applicable form of interstitial applicator, and there are many localities in which needles cannot be used to the best advantage.

The advantages and disadvantages of needles and implants in various conditions within the oral cavity and pharynx are discussed.

The technique of implantation and manner of calculating dosage from gold seeds is described.

5. The Methods and Results of Treatment of Oral Cancer at the Massachusetts General and Collis P. Huntington Hospitals.

Channing C. Simmons, M.D., Boston, Mass.

The paper is based on a study of 763 cases of oral cancer treated by surgery and radiation at the Massachusetts General and Collis P. Huntington Hospitals between the years 1918–1924. The rules advocated by the American College of Surgeons in reporting the results of treatment of carcinoma have been adopted and no case is spoken of as a cure unless it is living without disease at least five years after treatment, and the diagnosis has been confirmed by a pathological examination. If these rules are strictly adhered to the percentage of cures following surgery, using the term to include cauterization and the use of the electro-surgical knife, greatly exceeds that following radiation treatment. In the advanced cases, life was greatly prolonged by radiation, and much harm may be done by ill-advised surgery.

The degree of malignancy as determined by microscopic examination of the tissue had a distinct relation to the prognosis and should influence the choice of treatment. In certain cases a combination of radiation and surgical treatment gives the best results. The methods of treatment of the cases in the different clinical groups is discussed.

This group of cases is still under investigation but we have seen no reason to make any radical changes in the method of treatment.

6. The Treatment of Metastatic Involvement of the Neck Secondary to Intra-Oral Cancer.

Orville N. Meland, M.D., Los Angeles, Calif.

The lymph nodes in the neck have a definite function, and up to a certain point they are a first line of defense in the embolic progress of intra-oral cancer. Associated pyogenic infection of the primary lesion may or may not determine this possibility of regional glandular involvement. For these reasons our methods of treating metastatic nodes are conservative. Patients are placed in one of three groups and are treated according to the outline given below.

1. *Prophylactic Group.* These are patients in whom no clinical evidence of disease of a palpable node is made out. They are subjected to external irradiation to the point of saturation on the side on which the metastasis may be expected, and one-half of this amount is administered over the opposite side. If no glands appear during the following year, nothing more is done, but if a node appears the patient is treated as in the following group.

2. *Surgical Group.* These patients have movable palpable nodes. Roentgen irradiation as in Group 1 is carried out, and if no change is noted, the involved area is carefully exposed by electro-surgical methods. The fascia, nodes and adherent submaxillary gland

are removed. Platinum radium needles are then placed around the wound and left in situ for five days, or the wound is closed and a radium pack is put over the operative site at 3 cm. distance, a week after operation.

3. *Palliative Group.* These patients have bilateral cervical involvement of the nodes or they have massive fixed involvement of the nodes on one side. They are frankly inoperable and are treated with two objects in mind: (*a*) to retard the progress of the growth, and (*b*) to relieve pain and prevent the masses from breaking down. This is done by surface irradiation either by roentgen rays or radium packs.

Discussion: Dr. George E. Pfahler, Dr. William Neill, Dr. Fielding O. Lewis, Dr. B. F. Schreiner, Dr. Arthur C. Heublein, Dr. Henry K. Pancoast, Dr. Lawrence B. Taussig, and Dr. George M. Dorrance.

Summary of Group of Papers by Dr. Douglas Quick.

General Discussion.

4:00 P.M. Members and guests leave Hotel Adelphia by bus for the du Pont Gardens to be the guests of Mr. Pierre S. du Pont. (See April number for complete announcement.)

Tuesday, June 9, 1931

Morning Session

9:00 A.M. Executive Business Meeting
9:30 A.M. Scientific Session

Symposium on Carcinoma of the Breast
Burton J. Lee, M.D., *Chairman*

1. Results of Irradiation in Carcinoma of the Breast from 1902 to 1928.
G. E. Pfahler, M.D., Philadelphia, Pa.

2. Pulmonary Fibrosis Following Irradiation Treatment of Mammary Cancer.
G. L. Fike, M.D., Atlanta, Ga.

3. Results of Postoperative X-ray Therapy for Cancer of the Breast: A Report of 103 Consecutive Cases Treated more than Five Years Ago.
U. V. Portmann, M.D., Cleveland, Ohio

4. Radiation Treatment of Inoperable Mammary Cancer.
Frank E. Adair, M.D., New York City

5. The Use of Gold Filtered Radon Wires in the Treatment of Mammary Cancer.
George T. Pack, M.D., New York City

6. A Further Report on Interstitial Measured Irradiation in the Treatment of Mammary Cancer.
Burton J. Lee, M.D., New York City

Discussion to be Opened by: James Ewing, M.D., Henry K. Pancoast, M.D., Ralph E. Herendeen, M.D., Damon Pfeiffer, M.D., Max Cutler, M.D., and Ira S. Kaplan, M.D.

1:00 P.M. Luncheon served at Hotel Adelphia to which members and the official guests are invited, as guests of Drs. Pfahler, Newcomet, Schmidt, Clark, Widmann, and Weatherwax. Announcement of election of Honorary Members and responses.

Tuesday, June 9, 1931

Afternoon Session

2:00 P.M. Executive Business Meeting
2:30 P.M. Scientific Session

Symposium on Malignancies of the Female Genital Tract
Henry Schmitz, M.D., *Chairman*

1. Carcinoma of the Cervix.
William P. Healy, M.D., New York City

2. Carcinoma of the Body of the Uterus.
H. H. Bowing, M.D., Rochester, Minn.

3. Benign Hemorrhages of the Uterus.
Brooke M. Anspach, M.D., Philadelphia, Pa.

4. Endometriosis.
Oscar L. Norsworthy, M.D., San Antonio, Tex.

5. A Carcinoma Digestive Substance.
Maurice Sittenfield, M.D., New York City

General Discussion.

THIRD INTERNATIONAL CONGRESS OF RADIOLOGY

The Third International Congress of Radiology will be held in Paris, July 26–31, 1931, under the High Patronage of M. le President de la Republique, the Honorary Presidency of Madame Curie and the Executive Presidency of Dr. Antoine Béclère. All Congress meetings will take place in the amphitheaters of "la Sorbonne," 47, rue des Ecoles.

Congress Committee

President: Dr. Antoine Béclère

Vice-Presidents: Dr. Regaud, Dr. Belot, Dr. Cluzet, Dr. Rechou

General Secretary: Dr. Ledoux-Lebard

Secretaries: Dr. P. Gibert, Dr. Claude Béclère

Treasurer: Dr. H. de Rothschild

Adj. Treasurer: Dr. Morel-Kahn

Congress Program

Sunday, July 26

Meeting of the delegates of the 26 countries officially represented.

Opening of the exhibition of electro-radiological apparatus.

Official ball welcoming the delegates.

Monday, July 27

Opening meeting of the Congress in the "Grand Amphitheatre de la Sorbonne," in the presence of M. le President de la Republique.

Beginning of work of the Sections.

Tuesday, July 28

Question of the day to be discussed and work of Sections.

Evening at the Opera.

Wednesday, July 29

Question of the day to be discussed and work of Sections.

Visit to the exhibition of apparatus.

Thursday, July 30

Question of the day to be discussed and work of Sections.

Subscription banquet.

Friday, July 31

Work of Sections.

General closing meeting of the Congress.

Night festival at the Colonial Exposition.

Questions to be Discussed

During the opening meeting Professor Forssell of Sweden will speak on the "Social Struggle against Cancer."

Four questions are to be discussed at the Congress, each of which will be presented in a thirty minute lecture at the general meeting, all sections present, by the following authors designated by the radiological societies of their respective countries:

Dr. Cole (U.S.A.): "Radiological Examination of the Mucosa of the Digestive Tract."

Dr. Lynham (England): "Pre- and Postoperative Treatment of Cancer of the Breast by Radiation (Recurrence and Metastases Excepted)."

Dr. Haenisch (Germany): "Radiological Examination of the Urinary Apparatus by Excretion of Opaque Substances."

Dr. Milani (Italy): "Radiotherapy of Inflammatory Diseases."

Communications

More than 300 communications have been announced. They will be divided among the following six sections:

1. Roentgen Diagnosis
2. Roentgen and Curie Therapy
3. Radiophysics
4. Radiobiology
5. Electrology
6. Natural and Artificial Heliotherapy

Members of the Congress will receive a volume containing the summaries of the 300 communications before the opening of the Congress.

Commission of Measures: The Commission of Measures, on which each of the twenty principal countries is represented by a physicist and a physician, will continue the work begun in Stockholm on the International unification of measures.

Exhibitions: An exhibition of books and of radiological publications will be held at the Sorbonne. Those wishing to exhibit books or publications pertaining to radiology and allied sciences should address the Librairie Masson, 120 Boulevard Saint-Germain, Paris. An exhibition of electro-radiological apparatus will be held at "La Porte de Versailles."

Entertainments: The active and associate members of the Congress are invited to the three following entertainments: (1) Meeting of welcome, with dance, on Sunday, July 26. (2) Opera, evening of Tuesday, July 28. (3) Night festival at the

Colonial Exposition on Friday, July 31. A subscription banquet will be held on Thursday, July 30.

Ladies Committee: A Ladies Committee will organize excursions in and around Paris and visits to museums for the associate members of the Congress. The Congress members will also be able to visit the Colonial Exposition.

Those attending the Congress will benefit by a reduction of 50 per cent on the fare to and from the Congress, on the French railways.

After the Congress, from August 2, seven different travelling parties will be organized by the Tourist Office of the Congress to visit the principal tourist regions of France:

	Francs
1. Lac du Bourget—Lac d'Annecy—Chamonix-Mont Blanc—Evian (August 2 to 9)	1,650.
2. Aix les Bains—Lac du Bourget—Route des Alpes by automobile-Nice—Monte Carlo—Cote d'Azur (August 2 to 10)	1,500.
3. Carcassonne—Route des Pyrenees by automobile—Font Romeu—Luchon—Biarritz—Cote d'Argent (August 2 to 10)	1,800.
4. Normandie—Mont St. Michel—Cote de Bretange by automobile—Vannes (August 2 to 9)	1,490.
5. Vittel—Lakes and Passes of the Vosges—Alsace—Strasbourg (August 2 to 7)	1,040.
6. Vichy—Auvergne—Puy de Dome (August 2 to 6)	685.
7. Castles of the Loire—Blois (August 3 to 6)	555.

During these tours the members of the Congress will visit the principal thermal and mineral watering places.

The Tourist Office of the Congress can also organize, according to the wishes of those attending, any tour or stay in France after the Congress, either separately or in parties. Members of the Congress wishing to take advantage of this should address the Office of the Congress.

Congress Enrollment: Active membership in the Congress is open only to members of radiological societies and to persons accepted by these societies (fee for active membership—300 Francs). Wives and children of members of the Congress will be admitted as associate members (fee for associate membership—50 Francs).

Please send all information, enrollment or subscription fee to the Office of the Third International Congress of Radiology, 122 rue la Boëtie, Paris, France.

"CHRONIC HYPERLASTIC TUBERCULOSIS OF THE COLON" A FURTHER NOTE

To the Editor:

In the recent article by Dr. Goldfarb and myself on "Chronic Hyperplastic Tuberculosis of the Colon" which was published in the March, 1931, number of the Journal, the third case that was quoted, we remarked, was not operated upon. However, the case was included because of a similarity to the preceding two cases, because the patient had pulmonary tuberculosis and the course and location of the disease was such as to make the diagnosis of hyperplastic tuberculosis of the colon apparently a safe one. We were careful to note, however, that there was a definite possibility that this case might be one of the nonspecific granulomata which we are finding more and more often, the differential diagnosis being impossible. The case has recently come to operation; a nonspecific granuloma of the terminal ileum was found with no involvement of the cecum or ascending colon and the resected terminal ileum was so proved at pathological examination.

We would appreciate your publishing this letter in your Journal, first, to correct our erroneous diagnosis and second, to emphasize once more the impossibility of differential diagnosis in stenosing lesions of the colon.

MARCY L. SUSSMAN

Vol. XXV, No. 5

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, 105 Rutledge Ave., Charleston, S. C.

ANALYSIS OF THE FLAT GRID AND SOME LESS EXCENTRIC FORMS*

By HOLLIS E. POTTER, M.D.
CHICAGO, ILLINOIS

I. IT HAS been sufficiently brought out that in a parallel strip flat grid the center of operation is far dissociated from the center of curvature (at infinity) and that during movement a disalignment of metallic strips with reference to the path of rays must occur. It is assumed in the following study that all strips are inclined toward the operating point and that this coincidence of centers may take place at the middle of any given stroke.

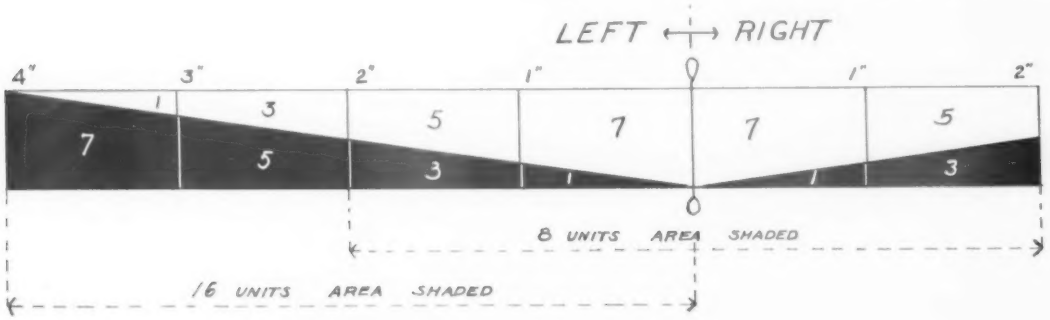

FIG. I PRIMARY RAY ABSORPTION IN FLAT GRIDS.

II. *Effect on Primary Efficiency*. In the middle of the stroke, which will be called the o position the grid allows the passage of all primary rays not absorbed in the very thin edges of the strips. At this exact point it equals the normal grid in primary ray transmission. When moved from the o position in either direction some of the primaries are absorbed in the strip faces. Moved farther this quantity becomes increasingly larger up to the "shut-out" point where all direct rays are stopped by the grid and its primary efficiency becomes zero. With every increase in the width of the strip shadows there takes place a complementary narrowing of the intervening light streams.

The law of grid absorption is best studied from a single stroke beginning at the o point and extending to the left 4 inches as shown in Figure 1. Here the shut-out point is 4 inches and the actual width of the strip shadow cast at various distances from the o position is seen in the height of the shaded area at points marked 1, 2, 3, and 4 inches. The shadow effect on the film, however, is not to be expressed by the simple series 1, 2, 3, 4, etc., but by the series 1, 3, 5, 7, represented by the heavily inked areas thus marked. The disalignment is small during the first inch of movement and the small triangular shaded area marked, I, results. This area is the product of the intensity (or height) of the shadow times the time during which it acts. Similarly the shaded areas marked 3, 5, and 7, represent correctly the shading effect or primary grid

* Received for publication January 17, 1931. This is the third in a series of articles on grid diaphragms by Dr. Potter. A fourth article entitled "The Grid Diaphragm Principle Applied to Roentgenography of the Paranasal Sinuses" will appear in the June number of the Journal.—Ed.

absorption during successive inches of movement. The total shading effect during this run of 4 inches to the left is the summation of 1, 3, 5, and 7, or 16 units, 16 times as much as was produced during the first inch alone.

It is probable that this high rate of increase of direct rays lost during progressive stages of disalignment has not been fully appreciated.

Suppose now that an equal or 4-inch grid movement were made to start at a point 2 inches to the right of the 0 position and extend to a point 2 inches to the left. The total grid absorption is now represented by the two smaller areas marked 1 and 3 in the shaded areas which upon summation total only 8 units, half the quantity produced in the 4-inch run located all on one side of the 0 position.

This brings out graphically the high penalties of a long stroke and shows that for maximum efficiency in the use of a flat grid the exposure should start and stop on opposite sides and at equal distances from the 0 position.

The illustration used above was from a grid that conveniently shut-out at 4 inches. From Figures II to V a graphic idea is obtained of primary loss in grids of different ratios designed to operate at 24-inch distance. Figure II simply introduces the shadow formation in a 1 to 4 grid. Figure III shows the proportionate width of strip shadows and light streams at the 1, 2, and 4-inch points from the 0 position. Figure III-A graphs this 1 to 4 flat grid operated at 24 inches, showing intensities of light and shade at various points. Figures IV and IV-A represent the same quantities for a flat grid 1 to 5 ratio and Figures V and V-A for one of 1 to 6 ratio.

These quantities are approximately correct for a single strip in a flat grid and it was brought out in the previous article that the disalignment of one strip is virtually the disalignment of all strips when operating at the designed center.

Referring back to Figure 1, it is noticeable that if the grid were moved but 2 inches, of which 1 inch were either side of the 0 position, the total primary grid absorption represented by the small shaded triangles marked 1 and 1 would total but 2 units whereas the unshaded areas above marked 7 and 7 total 14 units, giving the relatively low absorption of one-seventh the total primary energy.

III. *Effects of Scattered Ray Absorption.* The disalignment present in a flat grid is known to reduce the number of primaries reaching the film. Does it also reduce the number of scattered rays? No. The scattered rays start from all points above the grid and proceed in undiminished quantity through the slots or into the metal of the strips in a manner independent of disalignment. With this in mind one can compute the effect of disalignment upon the purity of ray mixture (in percentage of direct) emerging below the grid, using again the data furnished by Wilsey.

Suppose the disalignment were great enough to produce half a "shut-out" of primary radiation, 50 per cent efficiency. The scattered rays, undiminished in quantity, will be absorbed by a ratio 1 to 6 grid to the extent of 89 per cent, the remaining 11 per cent being passed on to the film.

Below 6 inches of water the intensity of scattered rays is 4.9 times as great as direct, or 490 parts scattered to 100 parts direct. With half a "shut-out" but 50 parts of direct then pass through the grid together with 11 per cent of 490 parts scattered or 53.9 parts scattered. The purity of the mixture upon emergence can therefore be represented by the ratio of direct rays to the mixture, the number 50 divided by 103.9, or 48 per cent.

For the effect of disalignment this is to be compared with the purity of mixture emerging below a normal grid or a flat grid placed in the 0 position. The transmission of direct is now 100 parts and the scattered unchanged at 53.9 parts. The purity of the mixture is the ratio of 100 to 153.9, or 65 per cent.

At the half "shut-out" point, the normal 65 per cent purity has been reduced to 48

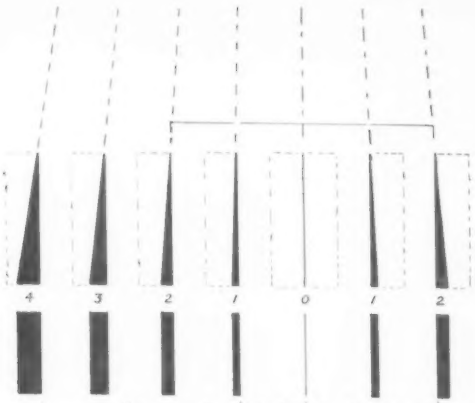

FIG. II SINGLE STRIP SHADOWS
1 TO 4 - FLAT GRID - 24" RADIUS

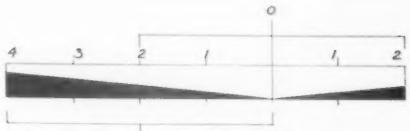

FIG. IIIA FLAT GRID - RATIO 1 TO 4

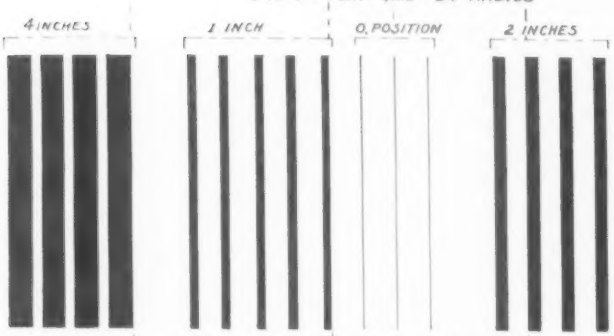

FIG. III - FLAT GRID RATIO 1 TO 4
RELATIVE WIDTH OF STRIP SHADOWS AND LIGHT STREAMS.

FIG. IVA - FLAT GRID
RATIO 1 TO 5

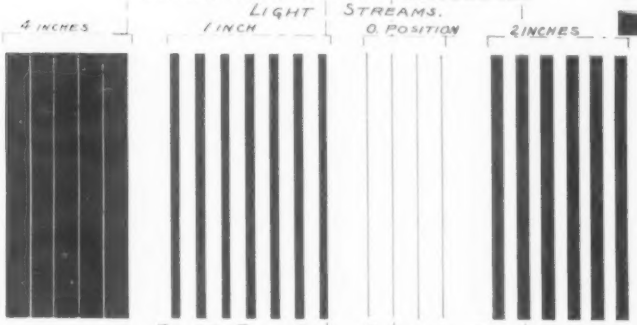

FIG. IV FLAT GRID RATIO - 1 TO 5

FIG. VA - FLAT GRID
RATIO 1 TO 6

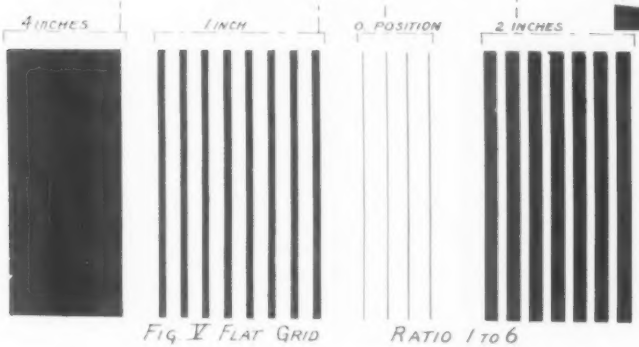

FIG. V FLAT GRID RATIO 1 TO 6

per cent, a drop of 17 points, or 40 per cent. From Figure V-A it can be seen that this point lies just inside the point 2 inches distant from the 0 position in a 1 to 6 flat grid operated at 24 inches.

IV. *Effect on Definition.* Aside from the size of focal spot within the roentgen tube the factors which determine definition are the tube-film distance as compared with the patient-film distance. Definition would be greatly improved in all grid work if grids were designed for maximum tube-film distance and minimum patient-film distance. These principles are common to concentric and excentric grids and would deserve no special mention at this time if they were capable of being carried out with equal facility on both types.

In the practical construction of flat grid apparatus, however, there are two physical factors which lend difficulty in obtaining a minimum patient-film distance. First, all flat grid cover material shows considerable deflection under slight load which is not present if the same material be given a curved form. Even slight curves give small angles of deflection and allow the cover to be permanently anchored with small clearance space between it and the grid without fear of contact. The fixed transparent cover of a flat grid must usually be made of thicker, more rigid material and a larger clearance space provided for the inevitable stretch and sag. A flexible anchorage of the grid apparatus so that it can follow the sag seems commendable.

Second, when a flat grid is incorporated into a table so that its transparent top serves as a grid cover it is difficult to design the side frames of the table so narrow that they will fail to interfere with the placement of cassettes. All the early tables were faulty in this regard. To use a stock grid apparatus it was of necessity anchored low and the clearance space above the grid became outlandishly in excess of other requirements. On some makes the writer measured a patient-film distance of 2 3/4 inches and the least was hardly under 2 inches. But little thanks were bestowed upon a friendly criticism of this fault but it is noticeable that it has been largely corrected, often by very ingenious contrivances.

V. *Tendency to Line Formation on Films.* In a smooth running flat grid apparatus of modern design there arises a tendency to form visible lines on the film when the grid travel has reached a point about one third of the distance between the 0 position and the shut-out point, and continues to the shut-out point. In case the tube is improperly placed with reference to the midline of the grid this error produces additional disalignment even though the grid stroke was properly centered. Arguments for a balanced short stroke are manifestly as important from the standpoint of line formation as for preserving high primary grid efficiency but are entirely predicated upon the assumption of a rigidly careful tube focus placement.

To obtain a proper explanation of the lines or "corduroy" effects obtained in the use of grid diaphragms, one must consider all causes. With a smooth running grid of any form it is conceivable that lines might be caused by one or more of the following factors.

(*a*) Oscillations in the tube which give momentary high voltage effects either at a make or break exposure.

(*b*) Gross irregularities in electrical conditions which might give uneven exposure at intervals.

(*c*) Over-fractions of exposure time beyond the time required for the transit of any exact number of grid units.

(*d*) Synchrony, near-synchrony, or multiples of synchrony between the number of pulses from the tube and the passage of grid strips over individual points in the film.

It takes but few experiments to become satisfied that under ordinary working conditions (*a*) and (*b*) can be ruled out as a common cause of "corduroy" so that irregularities in roentgen-ray intensity can be safely ignored.

Over-fractions (or under-fractions) of exposure beyond the time required for transit

of exact multiples of the grid unit are very important. (Here the unit is the combined width of one grid strip and slot.) To satisfy the laws for invisibility exact grid unit multiples should be traversed in order to cover and uncover each portion of the film for equal lengths of time. Exposures ordinarily begin at any phase of the grid cycle and end at any other phase. With our fine grid construction it would be impractical to try and control "start and stop" points, as suggested by Caldwell, for a coarse grid and short stroke. In our ordinary exposures the chances for accidental synchrony are very low and the probability of over-fractions very high. This accounts for the terms "probability" and "tendency" used in reference to line formation in these chapters and accounts for a lack of uniformity in the results in any series of carefully controlled experiments on the effects of disalignment.

These over-fractions of exposure have significance in the operation of any form of grid apparatus. Lines are probable whenever the over-fractions are high in ratio to the total exposure. When but few lead strips pass over a given film line as in a short exposure and short grid movement, the probability of lines from high ratio over-fractions is greatest. This is true in a normal and in a flat or excentric grid, but least in a normal where disalignment is absent and grid strip shadow narrowest. In a long stroke the effect of a small over-fraction is of too low ratio to be visible.

The full effect of over-fractions of exposure cannot be appreciated, however, without understanding the fourth possible factor (*d*) which deals with the frequency of tube pulses in relation to the speed of grid travel. In case roentgen rays were produced as a direct uniform light this would not be essential. But being ordinarily emitted from the tube in the form of 120 (or other number of) waves per second there arises a possibility of synchrony between tube pulses and grid strip transit over given points in the film; a much greater probability of conditions which approach synchrony; and a fair possibility of multiples or near-multiples of synchrony.

This establishes the fact that the *effective* grid movement may be much less than its actual physical movement. In full synchrony the grid will apparently be at a stand-still and its effective motion nil. With grid motion near synchrony its *effective* motion will be very small, as if advancing or retarding slowly. The longest *effective* grid motion occurs in a long stroke where by chance the moving rate is farthest away from synchrony or a multiple of synchrony and the many pulse effects widely distributed, fractionated in effect, and not "heaped up" as in "corduroy."

With any reduction in the amplitude of *effective* grid movement the result is that of a physical short stroke; the over-fractions of exposure are high in ratio and become visible in the films. Under conditions of disalignment as when working far from the o position in a flat grid the widened grid strip shadows especially tend to produce lines.

During the last month Mr. E. F. Flarsheim of Liebel-Flarsheim Company has run hundreds of experiments along this line which should be written up for publication and shown publicly. At my request also Mr. William Dee of General Electric X-ray Corporation and Dr. R. S. Landauer of Standard X-ray Company have verified the observations as to line causes and their elimination.

VI. *Can Film Lines be Prevented during Disalignment*? Yes. The theoretical analysis of line causes suggests a practical method which has now succeeded in experiments on grids of various forms when working under conditions of disalignment extending all the way from o to the shut-out point except in exposures of very short duration or in short grid runs. At this writing experiments on lineless films at half a second or less are still going on.

The method found adequate to "kill" the lines consists simply in substituting for the ordinary exposure of abrupt start and stop, one in which the intensity gradually rises at

"make" and gradually falls at "break" of roentgen-ray current as in Figure VI.

This exposure automatically cuts out the possibility of initial and terminal oscillation effects, and fractionates to invisibility

FIG VI CURRENT INTENSITY, RISES DURING TIME INTERVAL O-M AND FALLS DURING TIME INTERVAL N-O.

the over-fractions of exposure in anything but the shortest effective grid movements. While the duration of initial rise and terminal fall of ray intensity should theoretically depend upon the amount of over-fractin in any given exposure, this being unknown, a reasonable over-allowance of time is recommended. I have made no determination as to the necessary time for "feathering" these exposures but Mr. Flarsheim believes so far that one-sixth of the total exposure at start and one-sixth at stop is quite adequate. This agrees roughly with my impressions although I have frequently obtained perfect results in less time.

"Feathering" the beginning and end of exposure may be accomplished by a rheostat or in a number of ways. I have been warned against outlining my own methods because I work with direct current machines and they are not widely used. The principle is very simple and it may be expected that a simple device for "feathering" on any machine may be soon worked out by the manufacturers. It may be known in advance that films without line penalty may be easily made in stereo multiples through the spine on lateral shift and there are hopes that these results may be obtained in half a second or less. I have handed the problem over to the roentgen-ray experimenters mentioned above.

VII. *Summary of Points Which Contribute to the Effectiveness of Flat Grids.* The above recital of principles underlying flat grid diaphragms which violate to some extent the basic dicta originally laid down for efficiency and invisibility need no particular summary but are intended to emphasize the limitations in design and operation of this most convenient form.

The following constructive inferences may be drawn:

(*a*) An efficient flat grid must operate only during transit from point to point equally balanced by the central or O position.

(*b*) Any great amplitude of motion produces a rapid increase in primary ray loss, a diminished purity of ray mixture upon emergence and a disalignment of metallic strips favorable to line formation on films.

(*c*) The main cause of lines on film during disalignment is the over-fraction of exposure beyond the transit time for exact multiples of grid unit. These over-fractions may be of high ratio in long as well as in short stroke exposures if the *effective* stroke has been modified by a near-pulse-grid-unit synchrony.

(*d*) The line-producing effect of these over-fractions is avoided by obliterating them. To do so one has only to kill the abruptness at start and stop of exposure.

(*e*) Without such tempered exposure flat grids give early penalty from faulty tube placement. Their operating flexibility is less than in normal grids.

(*f*) High ratio grids have been given more credit than due. Even a 4 to 1 grid gives 83 per cent efficiency in scattered ray absorption which is quite sufficient for many purposes, and to be compared with 89 per cent efficiency in 6 to 1 grids.

(*g*) For definition the question of patient-film distance is one inherently more difficult in the design of flat grid apparatus than in one of curved form. Some special means of compensation for the sag of flat material is required.

VIII. The effectiveness of slightly curved grids designed to operate from a point considerably nearer than their center of curvature may be known from the foregoing analysis to measure up at points intermediate between the effectiveness of the flat and that of the normally curved. Upon disso-

ciation of centers there is a straight line increase in disalignment at the end of a given stroke. It should only be remembered that during unit increases in disalignment primary grid absorption increases according to the series 1, 3, 5, 7, etc.

Those objecting to the fully curved form which, in a width of 22 inches and curved to a radius of 25 inches, has a central depression of nearly 3 inches, might prefer a curve of 36 inches radius, dropping away less than 2 inches at center, or one of 72 inches which would curve down less than an inch. Such high radius curvature grids made to operate at small convenient distance take penalties less than the flat grid.

LIGHT-PROOF BOX FOR STORING EXPOSED FILMS

By A. G. SCHNACK

HONOLULU, T. H.

FIGURES 1 and 2 are drawings of an inexpensive light-proof box for storing exposed films until it is convenient to develop them. The only feature worth mentioning is the sloping anterior surface of the box. This insures the film lying flat and not crumpling on itself; it also insures a slight projection of each film above the next one behind it, making the films easy to pick up. The box is so fitted into the table that the cover when closed lies flat, in the same plane as the table top. The notch described acts as a handle. A similar box can just as conveniently be built against a wall. The box may be lead-lined if necessary.

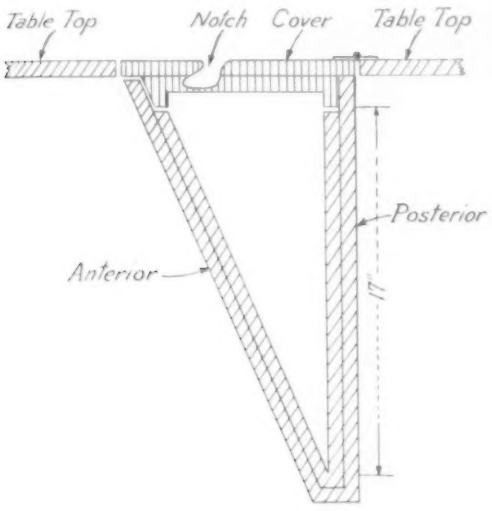

FIG. 1. Showing lateral cross-section of the box.

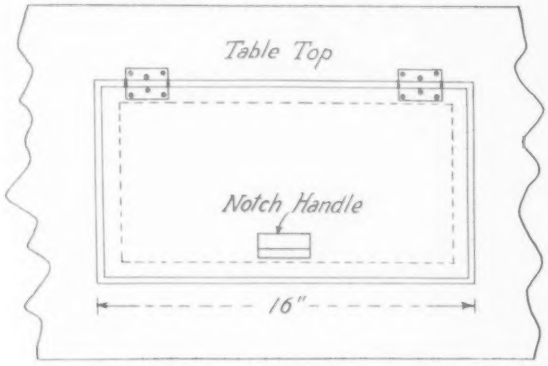

FIG. 2. The box viewed from above.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

Normale Anatomie des Kopfes im Röntgenbild. II. Teil. (Radiologische Praktika, Band XIII.) Von Universitäts-Assistent Dr. Karl Goldhamer, Leiter des Röntgenlaboratoriums an der I. Anatomischen Lehrkanzel (Prof. Tandler) in Wien. Cloth. Price, M. 120. With 44 photographic plates, 44 illustrative schemas and 26 projection diagrams. Leipzig: Georg Thieme, 1931.

This second part of Goldhamer's Atlas of the Skull possesses the same features which recommend Part I to the student of roentgenologic interpretation. The anatomy of the skull is demonstrated by twenty-two projections of the dried skull and an equal number of living subjects, carefully indexed and captioned in four languages with accompanying diagrams showing how the roentgenogram was obtained. In many respects this book is more useful than Part I for it is in the special view and oblique positions that the average roentgenologist gets into difficulty. The content is sufficiently inclusive. It deals with special positions for various parts of the skull, such as, mandible, mastoid, malar bone, orbit and nasal bones. The temporal bone, for example, is studied in the positions described by Schüller, Stenvers, Mayer, Sgalitzer-Fischer and Staunig-Gatscher. Roentgenography of the teeth is included.

The technical quality of the prints is satisfactory for the purpose although a few of them might have been slightly improved.

The roentgenologist, especially if he is more than ordinarily concerned with skull work, should not consider his library complete without both Parts I and II of this Atlas.

E. W. Hall

Das Röntgenverfahren. Ein Lehrbuch für den Arzt und die technische Assistentin. Von Dr. Kurt Kirschmann, Facharzt für Röntgenologie in Berlin. Paper, price 23 Marks; bound, price 26 Marks. Pp. 345, with 283 illustrations. Leipzig: Georg Thieme, 1930.

In Germany, the government has taken over the supervision of institutions training roentgen-ray technicians. A definite course is prescribed and all applicants have to pass a State Board examination. This book is written particularly for the use of the pupils in these courses which must be, to judge from the material presented, of a very high standard. Many physicians entering the field of roentgenology will also find valuable information in this book; the chapters on physics should be most worth their study. Although a physicist would probably ask for a more uniform treatment from the standpoint of modern atomic physics, it must be stated that difficult problems as, for instance, the theory of absorption, the quantum theory, and the Compton effect are so well explained that even a non-mathematical reader can understand it. The part dealing with roentgenographic technique differs somewhat from the methods as practised now in most American roentgen laboratories. However, most of the roentgenograms illustrating the books are all of fine quality. There are also short articles on technique in roentgen therapy, the application of roentgen rays in industrial fields, and on the fundamentals of radium therapy. Most practical and convenient is the appendix. It first relates the legal status of the technician, and offers then in condensed form, the fundamental, physical, mathematical, and chemical data of importance to the novice in roentgenology. Last but not least, there is a brief medical dictionary explaining the terms with which the roentgen-ray technician should be familiar. In the reviewer's opinion, this book should prove well suited for the purpose designated by its author.

Ernst A. Pohle

Books Received

A Textbook of Surgery. By John Homans, M.D., Assistant Professor of Surgery, Harvard Medical School. Cloth. Price, $9.00. Pp. 1195, with 513 illustrations. With a special bibliographical index and illustrations by Willard C. Shepard. Springfield, Illinois: Charles C. Thomas, 1931.

Roentgen Interpretation: A Manual for Students and Practitioners. By George W.

Holmes, M.D., Roentgenologist to the Massachusetts General Hospital and Assistant Professor of Roentgenology, Harvard Medical School, and Howard E. Ruggles, M.D., Roentgenologist to the University of California Hospital and Clinical Professor of Roentgenology, University of California Medical School. Fourth edition, thoroughly revised. Cloth. Price, $5.00. Pp. 339, with 237 illustrations. Philadelphia: Lea and Febiger, 1931.

Dental Roentgenology. By LeRoy M. Ennis, D.D.S., Assistant Professor of Roentgenology in the Thomas W. Evans Museum and Dental Institute School of Dentistry, University of Pennsylvania; Instructor in Dental Roentgenology in the Graduate School of Medicine, University of Pennsylvania. Cloth. Price, $6.50. Pp. 288, with 582 illustrations. Philadelphia: Lea and Febiger, 1931.

The Diagnosis and Treatment of Brain Tumors. By Ernest Sachs, A.B., M.D., Professor of Clinical Neurological Surgery, Washington University School of Medicine, St. Louis. Cloth. Price, $10.00. Pp. 396, with 224 illustrations, including 10 in colors. St. Louis: The C. V. Mosby Company, 1931.

Deep X-Ray Therapy in Malignant Disease. A Report of an Investigation Carried out from 1924–1929 under the Direction of The St. Bartholomew's Hospital Cancer Research Committee. By Walter M. Levitt, M.B., D.M.R.E., Medical Officer in charge of the Radiotherapeutic Research Department. With an introduction by Sir Thomas Horder, Bart., K.C.V.O., M.D., F.R.C.P., Chairman of the Cancer Research Committee. Cloth. Price, 10s. 6d. Pp. 128, with 10 illustrations. London: John Murray, 1930.

Verlauf der Wichtigsten Knochen- und Gelenkerkrankungen im Röntgenbilde: Eine anschauliche Prognostik. Von Privatdozent Dr. med. Victor Hoffmann, Oberarzt der Chirurgischen Universitätsklinik im Augusta-Hospital zu Köln. With German and English text. Paper, price RM 66.00; bound, RM 69.80. Pp. 264, with 584 illustrations. Berlin: Julius Springer, 1931.

Die Röntgenstereoskopie: Ihr Wert und ihre Verwertung. (Röntgenkunde in Einzeldarstellungen. Herausgegeben von H. H. Berg, Dortmund, und K. Frik, Berlin, Band 2.) Von Dr. J. van Ebbenhorst Tengbergen, Professor an der Universität zu Amsterdam, und L. E. W. van Albada, Generalmajor a. d. Amsterdam. Paper, price RM 16.60; bound, RM 19.50. Pp. 143, with 146 illustrations. Berlin: Julius Springer, 1931.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Brun, R. G., and Jaubert de Beaujeu, A. Un cas de pneumo-ventricules après blessure du crane. (A case of pneumoventricles following injury to the cranium.) *J. de radiol. et d'électrol.*, June, 1930, *14*, 338–343.

Cases of penetration of air into the cranial cavities as a result of injury to the skull have been reported in the literature only rarely. After a very brief review of all these cases, the author reports one of his own (the 10th in the literature) which is of peculiar interest. A man twenty years of age was shot in the head with a revolver three years previous to the examination. The bullet lodged in the brain and the patient was referred by his family physician for the extraction of the projectile. The first roentgenograms made for the purpose of localizing the site of the bullet revealed considerable air in the subarachnoid spaces and in the third ventricle. A second examination one day and a third two days later, showed that part of the air had absorbed, the right lateral ventricle alone remaining visualized. The patient did not want to submit to an operation and was discharged. From information received two months later it appeared that he was in good condition and apparently symptom-free.

The interesting feature in the case is that the bullet established a communication between the outside air and the fluid spaces of the cranium, there being a leakage of the cerebrospinal fluid with replacement by air. The difference in the appearance of the pneumoventricles in the roentgenograms was no doubt due to the variation of the leakage of the cerebrospinal fluid and consequent refilling of the fluid spaces with air. After healing of the fistula the air absorbed and there was return to normal.—*T. Leucutia.*

Crothers, Bronson; Vogt, Edward C., and Eley, R. Cannon. Encephalography in cases with fixed lesions of the brain. *Am. J. Dis. Child.*, Aug., 1930, *40*, 227–246.

Encephalography, the removal of cerebrospinal fluid and its replacement by air, is regarded by the authors as a formidable procedure which is probably uniformly followed by a meningeal reaction. In this paper they report their experience with this admittedly severe method of study as it was applied to a group of children with supposedly fixed lesions of the nervous system. They believe that the method reveals information of great value, and that, as a result, treatment can be carried out more promptly and more adequately in many cases.

They follow Pancoast and Fay who have used the term encephalograms as applied to the resulting films obtained by the introduction of air into the spinal canal after the withdrawal of fluid, in contradistinction to ventriculograms as applied to films obtained after direct puncture of the ventricles with insertion of air.

Neurological material in a children's hospital according to the authors can be divided fairly satisfactorily into three groups: (1) the children suffering from active or progressive disease, such as meningitis, tumor and the various well-demarcated syndromes, who are as a whole treated enthusiastically and intelligently; (2) children afflicted with prenatal defects, such as mongolism, spina bifida and the like, who are regarded with well-justified pessimism; (3) a group of children whose nervous systems have been attacked by any one of various agents, of which trauma and infection are the most important that have left anatomic effects or physiologic perversions. This group, which is very large can be subdivided into two groups: (1) children with poliomyelitis and (2) those with cerebral damage. This final subgroup is the one with which their paper is concerned.

Adequate study of these cases should establish three points: (1) the anatomic situation, (2) the physiologic residue, (3) a logical educational program. Ordinary methods of medical investigation do not adequately cover any of these three requirements in the group under discussion and they believe a search for better methods is justifiable.

The question as to whether an admittedly formidable procedure such as encephalography is reasonable is dependent, it seems to them, on answers to five questions. The first question, "Is definite diagnosis possible without it?" depends upon what is regarded as a definite di-

agnosis. They agree that encephalography should be restricted to cases in which there is doubt of the anatomic situation. Their present attitude is that good judgment of slight cases requires some information on the situation in the more severe ones.

The second question, "Is the procedure likely to clarify the situation and to what extent?" can be answered that approximately 50 per cent of the encephalograms in a consecutive series of nearly 200 cases have revealed definite evidence of distortion or enlargement of the ventricles or enlargement of the subarachnoid spaces suggestive of cerebral atrophy. There are, however, several points on which further information is highly desirable. Various details of interpretation should be viewed with obstinate skepticism.

The third question, "Is there any likelihood that conditions may be made worse?" can be answered by the fact that their experience shows that there is no likelihood of making matters worse. On the whole they have gained the tentative impression that after subsidence of the reaction, convulsions are less frequent and less severe for a period, and they have never observed any unexpected mental deterioration or increase of motor disability.

In answer to the fourth question, that of mortality, one child died suddenly nineteen days after encephalography had been performed.

In answer to the fifth question regarding the severity of the reaction, they state that if death is rare, reaction is the rule. During injection, sweating, pallor and vomiting are common, and rather alarming collapse is not rare. Beginning a few days after the procedure and lasting in some cases for several days, febrile reactions are common. During this stage, a stiff neck and Kernig's sign suggest meningeal irritation and this suggestion is supported by the following reports on fluids obtained by postoperative lumbar puncture.

One contraindication is greatly stressed: if intracranial pressure is elevated, encephalography is so dangerous as to be practically inadmissable. The authors respect Pancoast and Fay's routine establishment of pressure levels. However, they have become skeptical of manometric values in children and prefer to be guided by eyeground changes, cracked pot percussion note, etc. They have used an ordinary Potter-Bucky diaphragm on a horizontal table exclusively for the encephalogram exposures. Right and left stereoscopic and anteroposterior and posteroanterior single films are exposed. The lateral stereoscopic films are first made and then the head is turned from side to side beginning with an angle of about 60°, but gradually diminishing the arc till the face is directly up. The anteroposterior exposure is then made and after this the patient is turned face down and a posteroanterior film is taken to outline the posterior horns. Turning the head from side to side is done to equalize the remaining fluid in the ventricles.

They assume that the shadow of the ventricle is slightly larger than the ventricle itself. This error seems unimportant to them. They also assume that no great variation occurs with transient changes of pressure. A "normal film" shows symmetrical ventricles and even markings over the cortex. They have divided the films showing unusual distribution of air into four groups: (1) Reasonably symmetrical dilatation of ventricles. In general, they regard the dilatation as due to a deficit of brain tissue rather than as hydrocephalus from obstruction or lack of balance between formation and absorption of fluid. (2) Marked asymmetry of ventricles, presumably from unilateral atrophy. It will be noted that in general the displacement of the intracranial contents is toward rather than away from the enlarged ventricle. This is, of course, a vital point if tumor is one of the possibilities. (3) Evidence suggesting deepened subarachnoid spaces dependent on cortical atrophy. They are frankly dubious about some of these cases, but present them for what they are worth. (4) Absence of air in ventricles. If no other evidence of block exists, they regard failure of air to enter the ventricles as due to some unknown factor or to faulty technique. With increasing experience, they have had few such results. Obviously, such films add to, rather than decrease the complexity of diagnosis.

They believe that encephalograms properly taken and intelligently interpreted, give definite information of positive value in at least one-half of properly selected cases. In the remainder, negative facts of importance can be established. Encephalography should be used before final judgment is passed on the future of children severely handicapped by fixed cerebral lesions, unless other severe methods are demonstrably adequate.They are,of course,unable and unwilling to make diagnostic decisions on the basis of encephalograms alone.—*R. S. Bromer.*

Löw-Beer, Adalbert. Veränderungen am Schläfenbein bei florider Osteomalazie. (Changes of the temporal bone in florid osteomalacia.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, July, 1930, *42*, 102–107.

The author recently observed rather peculiar changes of the temporal bones in a case of florid puerperal osteomalacia which involved the entire skeleton leading to marked demineralization in the roentgenograms. The changes consisted in thickening of the labyrinth capsule with densification of part of the petrous bone, giving the impression that this portion of the skeleton remained unaffected by the osteomalacia. The author believes that the cause of this peculiar disturbance must be sought in unusual ossification conditions of the petrous bone, the dense zone around the labyrinth representing the enchondral layer of the labyrinth capsule which as is known transforms very early into lamellar bone with complete obliteration of the haversian canals and the vessels contained therein. One may assume, therefore, that this portion of the bone with time becomes independent of the general blood supply, its vitality being reduced to a minimum. Hence any change in the calcium metabolism resulting in osteomalacia of the entire skeleton may leave the petrous bone unaltered, leading to the rather unusual appearance in the roentgenogram.—*T. Leucutia.*

Crespellani, Carlo. Procedimento per ottenere l'immagine simmetrica delle due mastoidi. Incidenza sagittale obliqua antero posteriore. (Method of obtaining a symmetrical picture of the two mastoids. Anteroposterior oblique sagittal incidence.) *Radiol. med.*, May, 1930, *17*, 558–568.

The author describes the method that he follows for obtaining a symmetrical roentgenogram of the two mastoids on a film 13×18 with two poses, using the anteroposterior oblique sagittal incidence. The apparatus used is very simple and easily constructed: an orienting cap to mark exactly the middle sagittal axis of the skull, a goniometer for placing this axis at an angle of 52° with the plane of the film and a centering apparatus with an arrangement for the rotation of the head so as to avoid any lateral displacement of the point of support or the center of rotation. The method is illustrated.—*Audrey G. Morgan.*

NECK AND CHEST

Peterson, Edwin, Spalding, O. B., and Wildman, Otis. Psittacosis; a clinical and roentgenologic study of seven cases with post mortem observations in one case. *J. Am. M. Ass.* July 19, 1930, *95*, 171–179.

Following a brief historical résumé the findings in the 7 cases are reported in considerable detail. Daily roentgen study showed the pulmonary lesions to have a characteristic appearance, being circular, homogeneous, less opaque than lobar pneumonia, increasing in size daily and tending to migrate toward the apex. Differential diagnosis includes influenza, pneumonia and typhoid. Treatment is symptomatic though in these cases the use of an immune serum was of apparent benefit.—*E. W. Hall.*

Potte, N. W. Ueber die röntgenologischen Bilder der Lobulärpneumonien. (The roentgen appearance of lobular pneumonias.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, July, 1930, *42*, 69–81.

During the last two years 110 cases of bronchopneumonia and congestion of the lungs have been examined at the clinic of the Medical Institute of Leningrad. Of the 110 cases 25 came to post-mortem. In 12 a detailed histological examination of the lungs was made. In comparing the histopathologic findings with those of the roentgen examination it was found that the diagnosis was correct in the majority of the cases. In several instances, however, a differentiation between bronchopneumonia, congestion and tuberculosis was impossible. In most of these the gross pathologic examination furnished as little information as the roentgenograms and a correct diagnosis could be made only on the basis of histologic investigations.

The author describes in detail several typical and atypical cases, illustrating some of them with the pathologic specimens.

The conclusion is reached that a knowledge of the clinical findings is a valuable asset to the roentgenologist in diagnosing a roentgenogram of the chest. In doubtful cases serial examinations to study the progress of the lesion will help to substantiate the clinical diagnosis.—*T. Leucutia.*

Misske, Bruno, and Sylla, Adolf. Röntgenologische Studien des Lungenbildes bei Grippekranken der Epidemie 1928–29. (Roentgenologic studies of the lung images in grippe

during the epidemic of 1928–1929.) *Forschr. a. d. Geb. d. Röntgenstrahlen*, July, 1930, *42*, 4–18.

Most textbooks distinguish four forms of grippe: (1) the catarrhal (febrile); (2) grippe pneumonia (thoracic); (3) the abdominal, and (4) the cephalic (nervous, cerebral). Of the 126 cases observed by the authors, 80 were catarrhal, 33 pneumonia, 2 intestinal and 2 cephalic, while in 9 cases there were various complications.

In studying the roentgenologic appearance of the chest in the above cases, the authors found that they could be classified roughly into three groups: (*a*) catarrhal; (*b*) bronchopneumonic, and (*c*) protracted.

(*a*) The catarrhal form was characterized by more or less diffuse clouding of the lung fields with not infrequent prominence of the pulmonary arc. There was a marked root infiltration with swelling of the hilar lymph nodes. The picture was the result of a hyperemia of the lungs resulting in local circulatory disturbance. (*b*) The bronchopneumonic form presented a classical appearance in most instances. (*c*) The protracted forms were often complicated with chronic pneumonia, carnification, pleural thickening, empyema, relaxation of the diaphragm, etc. In all these instances the clinical findings were often of decisive importance.—*T. Leucutia.*

Pescatori, Guido. Le deformazioni e gli spostamenti degli ili nelle sclerosi polmonari e nelle sinfisi pleuriche. (Deformities and displacements of the hila in sclerosis of the lungs and adhesions of the pleurae.) *Radiol. med.*, May, 1930, *17*, 509–544.

The author first discusses the normal roentgen anatomy of the hila of the lungs, giving a rather diagrammatic description which is however useful in interpreting the different pictures. He says that the different forms of the latter, as they appear in the usual dorsoventral projection, are due to variations in the form of the thorax as well as of the heart and large vessels, and also to variations in individual constitution.

He describes the cinematographic picture of the thorax in the two types of respiration, costal and abdominal, as well as the movements which the hila undergo in these two forms, in the extreme phases of respiration. He calls attention to the fact that there may be decreased inspiratory movement of the hilus in unilateral pleural adhesions, and says that if the cinematographic picture of the hilus is studied carefully and other causes which may change it excluded, it may be of value in some cases in the indirect roentgen diagnosis of adhesions of the pleura.

He then describes the slight changes in the pictures of the hila caused by scleroses in the incisure pulling on them or by intrapulmonary scars; in some cases fibrous stripes can be seen which cause the pulling. The roentgen pictures of different forms of pleuropulmonary sclerosis are then given and the displacements of the hilar pictures described which are often seen in these lesions due to the fibrous tissue pulling on the hilus or to pulling of the heart, or both these causes together. A study of the displacements and deformities of the hila in sclerosis may show the degree of contraction of the lung tissue and the probable distribution of the newformed connective tissue. It may also explain certain clinical pictures. In conclusion, the author describes changes in the pictures of the hila caused by displacements of the mediastinum and heart and shows that these changes, though they are brought about by quite complex mechanisms and as a result, sometimes of obscure anatomical and pathological conditions, often help in the diagnosis of pleuropulmonary sclerosis.—*Audrey G. Morgan.*

Greer, Alvis E. Pulmonary syphilis. *Am. J. Syph.*, April, 1930, *14*, 195–198.

It has been stated that there have been approximately 200 cases of pulmonary syphilis reported in the medical literature of the world. Greer, from a review, believes that the literature contains a great many more authentic cases. Karshner classified syphilitic pulmonary pathology as follows: (1) the pneumonic form; (2) the gummatous processes; (3) syphilitic pulmonary sclerosis; (4) bronchiectasis; (5) suppurative processes, ulcerations and gangrene.

The physical signs, in contradistinction to pulmonary tuberculosis, are rather mild and insignificant, and the symptoms of syphilis are mild compared with tuberculosis. As a rule, there is little deterioration of the general health. The symptoms vary according to the type of pulmonary involvement. Greer reports a case, the diagnosis of which is based upon the following criteria of pulmonary syphilis enumerated

by Howard in 1924: (1) the absence of any grave symptoms proportionate to the physical signs; (2) the constantly negative tests for tubercle bacilli in the sputum; (3) the presence of concomitant signs of syphilis elsewhere; (4) the repeatedly positive Wassermann blood tests; (5) the suggestiveness of the roentgen examinations; (6) the strong evidence derived from the therapeutic test, and (7) the finding of spirochetes in a dark field examination of the sputum. The roentgen findings, while not pathognomonic of pulmonary syphilis, when correlated with the above clinical findings help to establish a diagnosis.—*J. H. Vastine.*

Reid, William D. The differential diagnosis of cardiovascular syphilis. *Am. J. Syph.*, April, 1930, *14*, 188–194.

Cardiovascular syphilis presents the following features: it is usually seen in patients from forty to sixty years of age; aortic insufficiency is common; enlargement of the heart is common; aneurysmal changes in the aorta may occur and when due to syphilis are usually seen between the ages of forty and sixty; dilatation of the aorta is present; the blood pressure is not increased above normal unless aortic insufficiency is present, when the diastolic pressure is correspondingly decreased.

The roentgen evidence of cardiovascular syphilis is as follows: increase in the size of the heart; blunting and dilatation of the root and ascending arch; flabby appearance of the heart roentgenoscopically.

Senescent Heart Disease. Senile heart and arteriosclerotic heart are also synonymous. They are differentiated from cardiovascular syphilis by the following features: they are seen in patients over sixty years of age; aortic insufficiency due to arteriosclerotic changes probably never occurs; aneuryism, when present, occurs in patients over sixty; the heart is either normal in size or even smaller than normal; enlargement of the aorta is usually in the knob at the left upper border rather than at the root as in syphilis; angina pectoris, coronary infarction, various forms of heart block, auricular fibrillation, and extrasystole are more common in the senescent heart than in cardiovascular syphilis.

Hypertensive Heart Disease. This presents the following features: hypertension is present; the heart is commonly greatly enlarged, more so than is usual in cardiovascular syphilis; aortic insufficiency is rare; aneurysmal changes do not occur, although the aorta may be dilated renal findings of a chronic or vascular nephritis are present; forceful cardiac impulse roentgenoscopically.

Rheumatic Heart Disease. Differentiated by history of attacks of chorea, tonsillitis and acute rheumatic fever; there is a history of previously recognized valvular heart disease extending over a period of years; the condition usually occurs in young individuals and terminates fatally before middle age is reached; valvular lesions with the associated murmurs are always present and sometimes multiple, the mitral valve being practically always involved; active cardiac infection suggests rheumatic heart; pericarditis is common in rheumatic heart but rare in cardiovascular syphilis; aneurysm, of course, favors the diagnosis of cardiovascular syphilis.

Bacterial Heart Disease. Mycotic aneurysms are usually small, multiple and rarely diagnosed ante mortem. Symptoms and signs of infection with pyogenic bacteria are present.

Nonsyphilitic Aortitis. This usually occurs in association with a cardiac lesion, is rarely conspicious clinically or roentgenologically and is usually not detected.

Other Cardiac Conditions. The various arrhythmias, Adams-Stokes syndrome, angina pectoris and coronary infarction occur in cardiovascular syphilis as well as other forms of cardiac disease.

Noncardiac Disease. Tabes dorsalis and cardiovascular syphilis may both be responsible for thoracic pains.

Pulmonary tuberculosis is not infrequently the clinical diagnosis in cases in which aneurysm is present and responsible for the symptoms. This differentiation roentgenologically is not difficult.

Asthma may be simulated by aneurysm.

Mediastinal tumor must be differentiated from aneurysm.—*J. H. Vastine.*

Casati, Annibale. Raro reperto radiologico in un tumore del torace. (Unusual roentgen finding in a tumor of the thorax.) *Arch. di radiol.*, May–June, 1930, *6*, 547–554.

A case is described in a man, aged forty-eight, with nothing special in his personal or family history. At the age of twelve years a tumor had appeared in the left supraclavicular fossa which increased in size on coughing and disappeared under normal conditions; it was completely reducible. About nine years ago he

had a dry pleurisy and for some months his voice had been weakening progressively. He complained of vague pain on the right side of the thorax posteriorly.

Roentgen examination showed a round tumor in the left upper lobe the size of a fist with distinct smooth outlines. It continued downward in the form of a peduncle extending to the mediastinum. When intrathoracic pressure was increased by coughing or otherwise, it disappeared from the lung field and a similar but somewhat smaller tumor appeared above the clavicle. There were transmitted pulsations in this tumor but none in the tumor in the thorax.

Apparently the opacity was caused by liquid contained in a cyst with distensible walls, part of which was inside and part outside the thorax, without septa, closed and not communicating with the vessels.—*Audrey S. Morgan.*

Lucas, Ernst, and Pollack, Herbert. Beitrag zur Diagnostik der Lymphangitis carcinomatosa in der Lunge. (Contribution to the diagnosis of lymphangitis carcinomatosa in the lung.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1930, *41*, 865–872.

After a brief review of the literature on carcinoma metastases to the lymph vessels of the mediastinum, the authors describe in detail 4 cases of lymphangitis carcinomatosa of the lungs, 3 of which were confirmed at post-mortem examination. In 2 of the cases the metastatic process resulted from a primary carcinoma of the stomach, in one from a carcinoma of the prostate and in the fourth from a carcinoma of the bronchus.

In all instances it was possible to make the diagnosis during life. Generally, if the roentgen films of the chest reveal an increased root shadow with thickened branches extending into the lungs and with numerous rounded cherry pit sized nodules (representing cross-section of the infiltrated lymph vessels) interspersed between the branches, the condition must be considered suspicious of lymphangitis carcinomatosa. Of course, the exclusion of tuberculosis and chronic bronchitis, as well as the demonstration of the primary carcinomatous lesion, will greatly aid in making the correct diagnosis.

It is interesting that in nearly all instances there was a thickening of the right upper interlobar septum and that death resulted from edema of the lungs.

The authors recommend that as soon as a carcinoma patient develops symptoms of an apparently harmless bronchitis, roentgen films of the chest be taken in order to rule out the possibility of lymphangitis carcinomatosa. An early diagnosis in this respect is important both from a diagnostic and a therapeutic standpoint.

The roentgenograms of all the cases described are reproduced in order to show the great similarity of the process to the chronic root infilations of other origin such as tuberculosis, bronchitis, etc.—*T. Leucutia.*

Haret, Devraigne, and Frain, Ch. Imperforation de l'oesophage. (Imperforation of the esophagus.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1930, *18*, 316–320.

A case of imperforation of the esophagus is described in a baby five days old. The barium meal introduced into the esophagus by means of a Nélaton sound entered into a pocket without descending into the stomach. The child died twenty-four hours later and post-mortem examination revealed that the esophagus terminated in this above pocket which communicated with the trachea. A sound introduced through the stomach emerged at the laryngeal orifice.

In connection with this very unusual case the authors review the literature of obliteration of the esophagus, going back as far as 1670, and discuss the different theories advanced for the explanation of the anomaly.—*T. Leucutia.*

Dyes, Otto. Intrathorakale, extrapleurale Granulationstumoren. (Intrathoracic, extrapleural granulation tumors.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, July, 1930, *42*, 45–54.

The author observed a rather unusual case which, on roentgen examination of the chest, presented two rounded shadows in the right lower chest just above the diaphragm. No accurate diagnosis could be made from the roentgen appearance alone but the test puncture revealed a cold abscess originating from a caries of the ninth rib. In connection with this case the differential diagnosis between various lesions of the pleura and chest wall are discussed.—*T. Leucutia.*

Brunn, Harold, and Faulkner, Wm. B. Jr. Intrabronchial drainage; its importance in the diagnosis and treatment of pulmonary

suppurations. *Surg., Gynec. & Obst.*, July, 1930, *51*, 115–124.

The anatomy of the bronchial tree is reviewed and the probable paths of secretion leaving the upper bronchi with the patient in various positions are outlined. An abscess in the middle lobe of the right lung produces few symptoms as long as the victim remains upright, but when he lies on his back, pus passes directly backward from the lesion which is in the front of the chest and enters the main bronchus to the lower lobe. This phenomenon produces cough and discomfort. A patient with hemorrhage from a tuberculosis of the right upper lobe may lie on his left side long enough for a clot to form in the bronchus leading to the left lower lobe with serious consequences. Care must be taken in placing a lung abscess case on the operating table. Pus may drain from the lesion which is placed uppermost into the bronchi on the normal side and produce enough obstruction to bring about a serious outcome. Lipiodol studies have been made to bring out the various types of intrabronchial drainage, and numerous clinical applications are cited. The signs and symptoms in pulmonary suppuration are often more dependent upon the areas to which the pus drains than on the actual site of the primary lung lesion. The part bronchoscopy plays in the diagnosis and treatment of these conditions cannot be overemphasized.—*C. L. Martin.*

Richards, T. K. Observations on the hearts of men engaged in athletics. *J. Am. M. Ass.*, June 21, 1930, *94*, 1988.

Not accepting the usual explanations of phenomena of extreme fatigue and collapse of athletes after strenuous exertion, the author conducted roentgen observations of athletes' hearts at rest and after exercise. Contrary to the common notion, the heart was in nearly every case found to be definitely reduced in size immediately following great activity. This is interpreted as due to a cramp of the cardiac muscles which he thinks may be a protective measure to prevent cardiac overstrain. Excess lactic acid may cause contraction, lessening circulation, producing cerebral anemia, with resultant collapse and lessened activity.—*E. W. Hall.*

ABDOMEN

Rubascheva, Anastasia. Die Blutversorgung der Gallenblase. (The blood supply of the gall-bladder.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1930, *41*, 957–965.

The author injected the vascular system of the gall-bladder with Hauch's opaque mixture or in a fewer instances with a suspension of bismuth subnitrite in glycerine and water, in 90 instances (37 cadavers of new-born, 28 livers of adults, 12 livers of dogs and 13 livers of rabbits. From the roentgenograms obtained the following conclusions were drawn: (1) the cystic artery shows great morphologic variations; (2) the region supplied by the cystic artery is not localized exclusively to the regio fossae vesicae felleae; (3) the type of anastomosis is in close relation to the distribution of the cystic artery; (4) the ductus choledochus has a definite number of blood supply sources, the chief among them being the cystic, hepatic, gastroduodenal and pancreaticoduodenal arteries. As accessory sources must be considered the right gastric, the superior mesenteric, the suprarenal and the artery of the adipose capsule of the kidney.—*T. Leucutia.*

Goldhamer, Karl. Ueber Petrifikation der Gallenblasenwandung. (On petrification of the gall-bladder wall.) *Fortschr. a. d. Geb. d. Roentgenstrahlen*, July, 1930, *42*, 95–102.

After considering the pathogenesis of calcification of the gall-bladder wall, as well as the differential diagnosis from other calcifications occurring in the right upper quadrant, the author describes in detail a case of complete calcification of the gall-bladder occurring in a man sixty-eight years of age. The condition was diagnosed by a simple flat film. Cholecystography by oral iodtetragnost failed to produce a filling of the gall-bladder, thus indicating obstruction. At operation a completely calcified gall-bladder with a walnut-sized stone in the choledochus was found.

Flörcken proposed the term "porcelain gall-bladder" for the designation of this rather unusual condition. He considered that the process was the end-result of an old inflammatory lesion and was consequently of no harm. While the author accepts the terminology of Flörcken he does not agree with him as to the harmlessness of the lesion. As in the case described, the cholecystitis may be associated with calculi in the gall ducts and such a complication may not be said to be entirely harmless.—*T. Leucutia.*

Mahar and Falcox, A. Un cas de triloculation gastrique avec hernie diaphragmatique. (A case of gastric triloculation with diaphragmatic hernia.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1930, *18*, 313–314.

This is a brief case report of a diaphragmatic hernia with triloculation of the stomach observed in a woman sixty years of age. It was thought that the lesion was on a congenital basis.—*T. Leucutia.*

Benedetti, Umberto, and Nicotra, Antonino. Falso diverticolo dello stomaco. (False diverticulum of the stomach.) *Arch. di radiol.*, May–June, 1930, *6*, 523–530.

A case of false diverticulum of the stomach is described in which nothing could be found on operation to explain the roentgen findings. The patient was a poorly developed girl of sixteen who had had stomach symptoms since she was four years old. Her genitals were poorly developed and she had never menstruated. The barium passed into a diverticular structure that looked like the efferent loop of a gastroenterostomy. It ran parallel with the greater curvature and ended in a cul-de-sac above. It did did not communicate with the intestine. The juxtapyloric region was deformed and pulled upward by adhesions. The bulb of the duodenum was deformed by adhesions. The appendix region showed the roentgen signs of chronic appendicitis. Operation showed chronic appendicitis but nothing to explain the diverticulum. Appendectomy was performed. Twenty days later another roentgen examination was made and showed the diverticulum just as it was before. The only theory that the author can think of that would explain the diverticulum is that a stomach ulcer had perforated and opened secondarily into the virtual space between the two folds of peritoneum. He does not believe there could have been a congenital longitudinal biloculation of the stomach for such an anomaly has never been described in embryology; nor does he believe that perigastric adhesions could have pulled the stomach out longitudinally so as to have caused a longitudinal bilobulation. The patient had pain for awhile after the operation just as she had had before but since then has been well and her weight and general condition have improved; she mensturated for the first time after the operation.

In the discussion Busi said that the existence of a perforated ulcer had not been proved and that the lining of the pseudodiverticulum had the appearance of stomach mucous membrane; he believed therefore that it was a longitudinal biloculation of the stomach. Balli said that an intraperitoneal infiltration would have caused a cord that the surgeon could have palpated. No such cord had been felt on operation, Tandoja recommended that if another operation became necessary the posterior wall of the stomach be examined more closely and if necessary the stomach be opened.—*Audrey G. Morgan.*

Hill, Luther L. Syphilis of the stomach. *Am. J. Syph.*, April, 1930, *14*, 199–214.

The diagnosis of syphilis of the stomach is based on the following factors (Chase): (a) positive Wassermann reaction—Todd and Sanford report 80 to 85 per cent of these cases as having a positive Wassermann reaction; (b) evidence of syphilis elsewhere; (c) demonstration of a lesion in the stomach by roentgen examination; (d) improvement under adequate therapeutic measures (antiluetic). The roentgen signs of gastric syphilis are those of Carman, namely, (1) filling defect of gastric outline, without a palpable mass; (2) hour-glass (dumb-bell type), (3) six-hour retention; (4) diminution of gastric capacity;(5) lessened pliability of the gastric wall; (6) absence of peristalsis in involved area; (7) absence of pyloric obstruction; (8) patient under cancer age; (9) absence of niche, incisura, etc. A diagnosis can usually be made only by a correlation of the above clinical and roentgen evidence.

The author studied patients in whom carcinoma and gastric ulcer as well as syphilitic gastritis were associated with syphilis. He emphasizes the importance of doing a Wassermann, particularly in colored patients, in all gastric disorders. Furthermore, if there is any evidence of syphilis, active antisyphilitic treatment should be instituted, whether the condition is cachexia due to syphilis, gastric ulcer complicated by syphilis, or syphilitic gastritis.—*J. H. Vastine.*

Chaumet, G. Étude de l'estomac en cascadé. (Study of the cascade stomach.) *J. de radiol. et d'électrol.*, June 1930, *14*, 321–328.

The author made a study of the mechanism of the cascade stomachs without organic lesion. The cases in which the biloculation was due to

perigastritis or other inflammations, to ulcer, neoplasm, etc., were not considered.

The following factors were analyzed in studying the mechanism: (1) congenital shortness of the small omentum; (2) pressure by extrinsic tumor; (3) compression by aerocoly, displacement of colon; (4) increase of the internal tension: aerogastry; (5) anatomic predisposition of the gastric walls, and (6) spasm.

It was found that all cascade stomachs presented: (1) marked aerogastry, the large quantity of gas distending the upper pole of the greater tuberosity, and (2) pronounced posterior dilatation of the greater tuberosity, the upper portion of the stomach adhering to the posterior wall of the diaphragm.

In studying the above conditions experimentally, by inflating a rubber tube the upper end of which was struck to a cardboard, the author was able to reproduce the mechanism of the cascade stomach. From this, he concluded that the morphologic predisposition together with the extensive adhesion of the greater tuberosity to the diaphragmatic dome (anatomic factor) and a marked aerogastry (pathologic factors) are sufficient to produce a cascade stomach. All other factors are contributory, their importance being uncertain and their discovery merely coincidental.—*T. Leucutia.*

Sprunt, Douglas H. Carcinoma and tuberculosis of the stomach. *Surg., Gynec. & Obst.*, Aug., 1930, *51*, 245–248.

The author adds one proved case of carcinoma and tuberculosis of the stomach to 13 others which he has collected from the literature. In each instance the histological picture of tuberculosis was demonstrated or acid fast bacilli were found in the tissues. Most of the patients had pulmonary or generalized tuberculosis. No attempt is made to explain the simultaneous occurrence of the two diseases.—*C. L. Martin.*

Buckstein, Jacob. The duodenal niche—a criterion in the healing of duodenal ulcer. *Surg., Gynec. & Obst.*, 1930, *51*, 109–113.

Roentgenographic evidence of the healing of gastric ulcers has been published by Friedenwald and Baetjer, Ohnell, Hamburger, Rosenthal, White, Buckstein, Shattuck, Diamond, Crohn, Weiskopf and Aschner, Moutier and Porcher, Moncrief and Nichols, and many others. However, similar references in the literature to the demonstration of healing of duodenal ulcers are relatively rare. This is partially due to the fact that the niche is often not present in the duodenal variety and obviously its disappearance cannot be shown in such cases. Carman and Sutherland could demonstrate a niche in only 13 per cent of their series but Buckstein claims a successful demonstration in 29 per cent of his cases examined at Bellevue Hospital. He reports 3 cases in detail which showed definite duodenal niches that completely disappeared while undergoing treatment.—*C. L. Martin.*

Ratkoczi, Nandor. Über meine Durchleuchtungsmethode fur das Duodenum. (On my method of roentgenoscopy of the duodenum.) *Fortschr. a d. Geb. d. Röntgenstrahlen*, June, 1930, *41*, 941–947.

As is known, the duodenal bulb during the roentgenoscopic examination is overlapped in most positions either by the shadow of the vertebral column or by the liver. The author advocates the examination in extreme right oblique (dextrosinistral) position in which both the vertebral column and the liver are out of the way. The slight overlapping of the bulb by the shadow of the stomach which is noticed in this position may be overcome by the use of a compressor which is of special construction. In a few instances it is necessary to supplement the method by the relief examination.—*T. Leucutia.*

Sandera, Robert. Zur Frage der Divertikel und Divertikuloide des Duodenum im Röntgenbilde. (On the question of the roentgen appearance of diverticula and diverticuloids of the duodenum.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, July, 1930, *42*, 54–69.

Forssell in 1916 described the following signs as characteristic of duodenal diverticula: (1) there is a fleck-shaped shadow with completely or partially rounded contour in the region of the duodenum; (2) this shadow persists (sometimes for one day following the barium meal); (3) and is slightly movable especially towards the posterior abdominal wall; (4) there is passage of the barium from the diverticulum into the lumen of the duodenum; (5) there is no sensitiveness to pressure; (6) the passage of barium into the duodenum occurs without stricture symptoms. Later other signs such as peristalsis (Freund), longitudinal arrangement of the folds of the

mucous membrane around the diverticulum etc., were added. The author was able to collect 7 unusual cases of diverticula and diverticuloids of the duodenum (all of which are described in detail and illustrated with numerous roentgenograms and specimens), and after analyzing them in the light of the above signs, he arrived at the following conclusions: The roentgen diagnosis of a true duodenal diverticulum is by no means certain. In the majority of the instances a diagnosis can be made without difficulty but in the borderline cases a differentiation from diverticuloids is practically impossible. The consideration of the clinical history and symptomatology leads to no better results. Therefore, nothing can be gained by the establishment of so many roentgen signs, the confusion created by these signs being greater than the benefits derived therefrom.—*T. Leucutia.*

Castronovo, Ettore. Reperto radiologico e reperto anatomico in un caso di invaginazione ileocecale cronica. (Roentgen and anatomical report of a case of chronic ileocecal invagination.) *Radiol. med.*, May, 1930, *17*, 568–574.

A case is described in a man, aged twenty-four, who had had signs of partial occlusion of the intestine for about three years. About two years ago there was a large cylindrical swelling extending from the splenic angle of the colon to the left iliopelvic fossa, following the direction of the descending colon. On the night of Aug. 26 he had violent abdominal pain and died in the morning. The terminal loop of the ileum was invaginated into the descending colon. The neck of the invagination was surrounded by a large sac of peritoneum. The terminal loop of the dilated ileum as it approached the sac contracted rapidly into an impervious fibrous cord which continued with a tract of invaginated intestine into the descending colon. The invagination was about 18 cm. long and the intussusceptum was ulcerated at its caudal end and very much congested. Immediately above the stenosis the ileum was perforated; the perforation had opened into the peritoneal sac. The colon was also perforated about 15 cm. below the neck.

A diagrammatic sketch is given of the roentgen picture from which the perforation was diagnosed. On the first examination an enormous invagination was seen, the head of which was in the rectum and the closed neck at the splenic angle of the colon. The sheath was impregnated with an opaque enema and distended without any passage of barium into the loop of ileum above the neck. When the opaque paste from the ileum passed the neck it passed directly into the sheath, forming a spiral. There was evidently a perforation of the intussusceptum into the sheath near the neck. Death was caused by partial evagination of the intussusceptum, so that the perforation near the neck, following the evaginated portion, opened into the peritoneum. In internal perforation great caution is necessary in giving opaque enemas in order not to cause just such an occurrence as this.—*Andrey G. Morgan.*

Edberg, Einar. Über den Wert der Röntgenuntersuchung bei akuter Darminvagination. (Value of roentgen examination in acute intestinal invagination.) *Acta radiol.*, June 30, 1930, *11*, 194–203.

Twelve cases are described and illustrated with roentgenograms. The author compared the roentgen pictures with the anatomical pictures found on operation and found that they agreed. They showed a definite difference between the ileocecal and the pure ileo-ileocolic type. This is of value in diagnosis because an early ileocecal invagination can often be replaced mechanically while an ileo-ileocolic invagination should always be operated on at once.

The roentgen picture of a simple ileocecal intussusception usually shows a broad cup-shaped interruption in the column of contrast medium and a small amount of gas in the small intestine, even after a relatively long while. In the roentgen picture of simple ileo-ileocolic intussusception the contrast medium is distributed in loops of varying thickness around the intussusceptum, which as a result gives the impression of an irregular spiral vacuum in the column of medium. The outer cylinder shows distinct folds of mucosa. The amount of gas in the small intestine is greater than in cases of ileocecal intussusception of the same duration. It should be remembered that an invagination low down on the ileum at a few centimeters from the ileocecal valve brings about a secondary involution of the cecum. The roentgen picture of this variety resembles that of the ileocecal type.—*Andrey G. Morgan.*

Nordentoft, Jacob. Sur l'examen radiologique de la désinvagination conservatrice

non chirurgical de l'invagination aiguë des enfants sous le controle des rayons de roentgen. (On the roentgen examination of the conservative non-surgical disinvagination of acute invagination in children under control of roentgen rays.) *J. de radiol. et d'électrol.*, July, 1930, *14*, 369-379.

The author attempted the disinvagination under roentgenoscopic control in 10 cases of acute invagination. In 6 the result was good. In the other 4 the attempt remained unsuccessful and immediate surgical intervention was necessary; one of the cases died shortly after the operation and 3 finally resulted in healing.

The 10 cases are briefly described and illustrated with numerous roentgenograms.

In discussing the value of the roentgenoscopic reduction of invagination, the author expresses the opinion that only those cases are amenable to such manupulation which show the typical roentgen picture as described by Brocq and Gueullette: arrest of the barium column with a concave line against a convex clear zone and, in fewer instances, an increased density, more or less sinusoidal in shape, in the midaxis of the barium column, due to abnormal shortening of the colonic segment. If the roentgen examination does not reveal these typical signs, the disinvagination under roentgenoscopic control may a priori be disregarded and an operation immediately proceeded with.

In unsuccessful cases, roentgenoscopic examination may sometimes be useful by giving valuable information to the surgeon as to the possible degree of reduction, as well as to the mobility or non-mobility of the invagination. In other instances it may lead to partial disinvagination, placing the affected segments of the bowel in the right half of the abdomen and thus greatly facilitating operative procedures.—*T. Leucutia.*

Pohl, Rudolf. Postappendizitische Abszesse im Röntgenbild. (The roentgen appearance of post-appendicial abscesses.) *Fortschr. a d. Geb. d. Röntgenstrahlen*, July, 1930, *42*, 19-36.

On the basis of several cases of his own and after a brief review of the literature the author discusses the roentgen characteristics of post-appendicial abscesses.

The following classification is used: 1. Perityphlitic abscesses; (*a*) completely encapsulated and (*b*) communicating with the neighboring organs, especially with the cecum (paratyphlitis, para-appendicitis). In the encapsulated perityphlitic abscess a change in form of the cecum is the most constant sign. This is due as a rule to the abscess pressing on the median aspect of the cecal wall, often producing a rounded defect. The mucous membrane of the cecum remains regular, a fact which often is very important in the differentiation from primary lesions of the cecum. There is a very marked sensitiveness to pressure of the entire right lower quadrant and in rarer instances there is a complete lack of filling of the cecum, the impression being that the barium passes from the ileum directly into the ascending colon (Stierlin's sign). If the perityphlitic abscess communicates with the cecum or the appendix barium may enter into the appendicial cavity. It must be mentioned, however, that this occurs more often with the barium enema than with the barium meal and therefore the author advises that in all doubtful cases a barium enema be employed without fear of producing aggravation of the inflammatory condition.

Differential diagnosis includes primary lesions of the cecum (tuberculosis, actinomycosis, carcinoma), invagination of the lower ileum into the cecum, primary tumors of the appendix and inflammation of the adjacent organs (infections of the adnexa, pelvic abscess, perinephritic abscess, Douglas' pouch abscess, etc.).

11. Abscesses distant from the cecum; (*a*) Douglas' pouch abscess; (*b*) subphrenic abscess, and (*c*) intraperitoneal abscess. In the Douglas' pouch abscess when there is a pressure on the rectal wall a barium enema often reveals a defect or stenosis of the rectum. The roentgen signs of subphrenic abscess are not discussed in this article. The intraperitoneal abscesses are occasionally diagnosed by the defect they produce on the intestinal tract or by the adhesions.

The author includes 5 cases (illustrated with typical roentgenograms) in order to prove the value of the procedure, and arrives at the conclusion that roentgen examination is quite helpful in the diagnosis of post-appendicial abscesses, especially as regards the exact localization and extension of the process.—*T. Leucutia.*

Béclère, H., and Porcher, P. Le diagnostic radiologique de la diverticulose colique. (The roentgen diagnosis of colonic diverticulosis.) *J. de radiol. et d'électrol.*, July, 1930, *14*, 380-390.

The authors discuss the differential diagnosis

of true and false diverticula of the colon and the means by which this can be made.

The problem varies according to whether the patient presents a clinical picture of a left-sided colitis, especially pelvic colitis, or the examination of the colon is carried out merely as a supplement to the study of the gastrointestinal tract, the diverticula being discovered accidentally.

In the first instance the diverticula take part in an inflammatory process and therefore should be termed "diverticulitis"; in the second, they appear independently of any other lesion and in consequence may be called "diverticulosis".

Anatomico-pathologically the diverticula may be divided into (1) true, when their walls include all structures of the intestine, (2) false, when the walls consist of only the mucosa of the intestine, and (3) pouch formations, when they are the result of deformities of the colon due to perivisceritis.

The following characteristics are discussed in the three forms: (*a*) site: true, chiefly in the sigmoid and left colon; false, on the entire colon except the sigmoid, and pouch formations, chiefly in the region of the hepatic flexure (place of right-sided perivisceritis), on the external wall of the ascending and the superior wall of the transverse colon; (*b*) volume: true, it never exceeds the size of a small pea; false, very variable, depending on the rhythm of peristalsis—large in the cecum and ascending colon (slow deep contractions), small from the left half of the transverse colon on (more rapid contractions); pouch formations, sometimes of enormous size depending on the portion of the wall embedded in adhesions; (*c*) number: true, occasionally single; false, very variable; pouch formations, very variable; (*d*) symmetry: true, asymmetric; false, symmetric, proof of parallelism of the incisures; pouch formations, never symmetric; (*e*) conditions of visualization: true appear after enema; false, never appear after opaque enema but always after barium meal; pouch formations, appear after both; (*f*) conditions of disappearance: true, persist; false, disappear; pouch formations, change their contours following evacuation of the colonic segment; (*g*) peristalsis: true, produce no modification of the peristalsis unless they are inflamed; false, produce no modification of peristalsis; pouch formations, modify the peristalsis on the portion of the colon involved.

Errors of interpretation are committed chiefly in the false diverticula, the normal folding of the mucous membrane being not infrequently diagnosed as diverticulosis. The combined examination by means of barium meal and barium enema will help to put one on the right track in the majority of instances. A small group will remain, however, in which a differential diagnosis will appear entirely impossible.

In case of inflammatory changes of the diverticula, the following three signs may be of value: (1) spastic contraction of the colon persisting following the administration of belladonna; (2) change in the contour of the colonic wall, a "wrinkled" dentate appearance being pathognomonic of colitis whatever the site of the lesion; (3) modification of peristalsis leading to intolerance of the barium enema unless a preliminary treatment by belladonna has been given.

The article is illustrated with several beautiful roentgenograms.—*T. Leucutia.*

Oka, Mitsutomo. Klinische Anwendung der "Lienographie," einer neuen Methode zur röntgenologischen Darstellung von Milz und Leber. (Clinical application of lienography, a new method for the roentgenologic visualization of spleen and liver.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1930, *41*, 892–898.

The author in a previous article (see abstract, this Journal, May, 1930, *23*, 576) published the results of his investigations on lienography in rabbits and dogs. It was stated there that the intravenous injection of one single large dose of thorium dioxide led to a good visualization of the spleen and liver but that the experimental animals died suddenly from shock. Later the administration of the thorium dioxide in repeated smaller doses increased the tolerance limit of the animals, no toxic effects having been observed. The investigations also brought out the fact that the colloidal thorium dioxide (thorium dioxide hydrosol) lodged in the pulp of the spleen, the Kupffer cells of the liver and the reticuloendothelial system as a whole.

The question arose as to whether the storage of the thorium particles in the reticuloendothelial system does not lead to a disturbance of the functions associated with this system such as formation of antibodies, histio-

cytes, monocytes and other circulating cells, and the formation of bile pigments, ferments, etc. Investigations carried out along this line revealed that if the injection was carried out by repeated small doses, no functional disorders could be observed even after the lapse of several months. In 7 rabbits which received a larger dose of thorium dioxide at one time certain blood changes occurred but these also proved of only temporary duration.

In view of the above experimental results the method was tried in 6 humans, all with normal liver and spleen. The thorium dioxide was prepared and injected as follows: A neutral 10 per cent aqueous solution was sterilized and divided into ampules of 11 c.c. each, and the ampules sealed. The contents of one ampule (10 c.c.) were mixed with 10 c.c. of a 10 per cent glucose solution and injected into the median vein every day or every other day until a good visualization of the spleen and liver was obtained. As a rule from 6 to 8 injections were needed, this giving a total dose of 0.07 to 0.15 gm. thorium dioxide per kilogram body weight. There was early visualization of the spleen usually following the third or fourth injection, while the liver shadow appeared later. In none of the cases were there any serious disturbances, although a slight fever with or without chills, diarrhea, general malaise and headaches were observed in 4 of the cases, appearing as a rule within a few hours following the first to third injection. Examinations carried out over a period of several months revealed that no injury whatever resulted. It seems thus that the method is harmless.—*T. Leucutia.*

Di Barbazza, J. A. Observation d'un cas de kyste hydatique de la rate. (Observation of a case of hydatid cyst of the spleen.) *J. de radiol. et d'électrol.*, August, 1930, *14*, 458–459.

A brief case report of a very rare localization of a hydatid cyst. The symptomatology dated back as far as 1913 and the dullness in the left hypochondrium gave rise to various diagnoses such as splenomegaly, malarial spleen, pleural effusion, etc. The correct diagnosis was made only after surgical intervention.—*T. Leucutia.*

GYNECOLOGY AND OBSTETRICS

Thoms, Herbert. Fetal cephalometry in utero. *J. Am. M. Ass.*, July 5, 1930, *95*, 21–24.

The method previously developed by the author for roentgen pelvimetry is now adapted to fetal cephalometry. In this procedure the perforated plate which serves to project a centimeter scale on the film is placed in the estimated occipitofrontal plane of the fetal head. A study of 149 cases ante and post partum shows that this estimation is sufficiently accurate for practical purposes. From tabulated cases rules for obtaining other diameters of the skull are formulated.—*E. W. Hall.*

Lash, A. F. Lipiodol pelvic cysts. *Surg., Gynec. & Obst.*, July, 1930, *51*, 55–60.

The history is detailed of a patient whose abdomen was opened twenty-two months after lipiodol had been forced into the peritoneal cavity by the uterine route. The pelvis was full of adhesions as a result of a double chronic salpingitis. The omentum was adherent in the anterior cul-de-sac and three cystic masses containing an oily substance were found in the interstices of this structure. When the oil was properly broken down a positive reaction for iodine was obtained. The patient went through a normal pregnancy after the lipiodol was injected without mishap. The author states that lipiodol has no value as an antiseptic and suggests that it be used in studying the female generative tract only in the absence of infection. In this way the formation of lipiodol cysts might be avoided.—*C. L. Martin.*

GENITOURINARY SYSTEM

Chauvin, E., and Emperaire, R. Sur la technique de la pneumopyélographie. (The technique of pneumopyelography.) *J. de radiol. et d'électrol.*, June, 1930, *14*, 344–346.

The exact localization of stones in renal calculosis is of primary importance. The use of opaque media does not always give the expected results since the shadows of the calculi are often superimposed by the shadows produced by the opaque media. It seemed, at least theoretically, that the injection of air would lead to better results. The method was repeatedly tried in practice but the pneumopyelograms obtained were of little diagnostic value.

In re-attempting the use of injection of air for the purpose of visualization of the kidney pelvis the authors found that certain technical criteria must be strictly observed in order to insure satisfactory results. Thus, because of the very rapid leakage of the air through the ureters, a

greater quantity of air must be injected into the renal pelvis, the injection being continued during the actual taking of the roentgenograms. It is also necessary that patient be placed in a lateral decubitus (lying on the opposite side from the kidney to be examined) so as to obtain a better drainage of the urine, this facilitating the entry of the air into the calyces. The air (which is pure atmospheric air) is injected with a 100 c.c. syringe under pressure of 60 to 80 c.c. water (controlled by Claude's manometer). It is essential that during the taking of the roentgenograms the pressure be kept steady. As a rule 30 c.c. of air suffices for a good pneumopyelogram. Following the roentgen exposure the air is withdrawn.

More recently the authors associated pneumopyelography with pyelography by the usual opaque media, carried out immediately after the withdrawal of the air from the kidney pelvis. The diagnostic information obtained in this manner was very instructive.—*T. Leucutia.*

Colaneri, L.-J. Pyelographie et urographie par urosélectan. Comparaison entre les deux méthodes. (Pyelography and urography by uroselectan; comparison of the two methods.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1930, *18*, 312–313.

The author used first the direct and then the intravenous pyelography (by uroselectan) in a case of right-sided hydroneophrosis. In comparing the two methods it was found that although the opacity produced by the uroselectan was less pronounced, the intravenous pyelography as a whole was of greater value inasmuch as it gave information with regard to the condition of the opposite side.—*T. Leucutia.*

Haret, Constantinesco and Picarda. A propos de quelques pyélographies par l'urosélectan. (Concerning pyelography with uroselectan.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1930, *18*, 309–311.

The authors report the results of 17 pyelographies with intravenous uroselectan. The method used was that of Swick and von Lichtenberg except that the injection was done somewhat faster, the first 40 c.c. being injected in two minutes and the rest in three minutes, with an interval of a few minutes between the injections. The method was well tolerated in the normal as well as in all pathologic cases.

Good roentgenograms were obtained except for the fact that the normal kidney was not always well visualized. Köhler and Ziegler have already suggested the idea of introducing a rubber balloon into the rectum or vagina for the compression of the ureters so as to obtain an increased concentration of the uroselectan and thus a better visualization of the normal kidney and ureters. The authors repeating these experiments, with Petersen's rubber balloon, found that the procedure is rather inconvenient inasmuch as it causes considerable pain and in one instance it led to a rupture of the vaginal mucosa. The distention of the bladder for the compression of the ureteral orifices, seems to give better results. The authors advise this method as a routine procedure.—*T. Leucutia.*

Ratschow, Max. Uroselektan in der Vasographie, unter spezieller Berücksichtigung der Varicographie. (Uroselectan in vasography, with special consideration of varicography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, July, 1930, *42*, 37–45.

Ther author previously experimented with injection of the veins for vasography by various opaque substances such as bismuth, iodipin and strontium bromide, but obtained very unsatisfactory resuls. Recently by making use of uroselectan he repeated the experiments (in rabbits) and succeeded in producing a very good visualization of the blood-vessels injected, the uroselectan proving entirely harmless.

Encouraged by these results the author decided to use the method on himself, and after applying a torniquet above the elbow he injected the vein of the dorsum of the hand (with 10 c.c. uroselectan). A roentgenogram taken immediately following the injection showed a good visualization of the vein of the forearm up to the elbow. There was no reaction whatever.

Later the method was used in 4 patients for the demonstration of varicose veins (varicography). In the course of these injections it was found that better results are obtained when injecting 15 c.c. of the uroselectan, the injections being given in fractional doses of 5 c.c., applying a slight massage of the veins affected between injections. The roentgenograms obtained are reproduced.

Further observations are necessary before arriving at final conclusions as to the practical value of the method.—*T. Leucutia.*

Hutter, Karl, and Sgalitzer, Max. Zur röntgenologischen Darstellung der Nieren und Harnwege durch intravenöse Injektion von Uroselektan. (The roentgenologic visualization of the kidneys and urinary paths by intravenous injection of uroselectan.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1930, *41*, 919–935.

The authors used intravenous uroselectan in 110 cases without observing any untoward effects. From a study of these cases the following indications are established: Intravenous uroselectan forms the method of choice in all instances with poor general health, in inflammations of the urethra, bladder and neighboring organs (adnexa), and in renal tuberculosis. It forms a valuable adjuvant in all cases in which the catheterization of the ureters is impossible, as for example in ureteral strictures, in stenosis or occlusion of the ureteral orifices, in certain cases of hypertrophy of the prostate, in atrophy of the bladder, in vesical hemorrhage, in fistulae of the bladder and in children. Finally, it may be used for the diagnosis of kidney conditions by increasing the density of the kidney shadow (nephrography), in certain developmental anomalies, in tumors of the renal parenchyma, which have not produced sufficient destruction so as to break into the kidney pelvis, in cysts of the renal parenchyma, etc.

It seems that roentgenoscopic examination can be advantageously combined with the roentgenographic method.—*T. Leucutia.*

Katz, Traian. Pyelografia intravenoasa cu uroselectan. (Intravenous pyelography with uroselectan.) *Rev. stiint. med.*, 1930, *19*, 624–636.

After a rather lengthy discussion of the literature on intravenous pyelography, the author describes the technique of injection of uroselectan, which is that used at von Lichtenberg's clinic.

The method is indicated: (1) in ureteral strictures; (2) in children; (3) in obstructive lesions of the bladder; (4) in obstruction of the ureteral orifice; (5) in deviations of the interior portion of the ureters, and (6) in obstructions of the median or renal portion of the ureters.

The contraindications are: (1) all acute infections of the bladder and adnexa, and (2) case of vesical tuberculosis. The method has given very satisfactory results and more recently has been applied in connection with functional tests of the urinary system.—*T. Leucutia.*

Editorial. Intravenous urography. *Surg., Gynec. & Obst.*, Sept., 1930, *51*, 421–423.

In 1923, Rowntree, Osborne, Sutherland and Scholl of the Mayo Clinic, showed that the renal pelvis and the bladder could be outlined roentgenographically following the intravenous administration of sodium iodide. Their suggestions relative to liver function led Graham to evolve the present plan of cholecystography. About 200 c.c. of a 15 per cent solution was used. This amount of iodine was very poorly tolerated by many patients and the shadows obtained were indistinct. Roseno prepared a substance containing a combination of urea and iodine which produced more satisfactory shadows but it was toxic to certain patients. Binz and Rath of Berlin had previously compounded an antiseptic for intravenous use called "selectan neutral" which contained a high concentration of iodine and a pyridine ring. In 1927 Hryntschak demonstrated the urinary tracts of animals with this substance. Swick working with Lichtwitz of Altona recognized the value of the selectan group in this type of work early in 1929 but obtained many toxic effects. Finally von Lichtenberg, Swick and Binz, working together, evolved a substance called "uroselectan" which was not toxic and gave good outlines of kidney pelves and ureters. Following a thorough trial by representative American urologists whose findings were presented at a recent meeting of the American Urological Association, uroselectan was placed on the market.

It seems likely that the intravenous method will be reserved for intolerant patients, patients with contracted tuberculous bladders, anatomical obstructions of the ureter, extensive vesical neoplasms, prostatic obstructions and impassable urethral strictures. It will also prove useful in studying infants and cases whose ureters have been transplanted into the rectum. Those who take up this new method should remember that the interpretation of a urogram is difficult and requires extensive experience.—*C. L. Martin.*

Kretschmer, Herman L. Intravenous urography. *Surg., Gynec. & Obst.*, Sept., 1930, *51*, 404–408.

Kretschmer has used uroselectan in the examination of 85 cases and states that his results

bear out all of the claims made for it. He obtained no reactions except an occasional temporary thirst and flushing of the face and head. The method was particularly successful in a group of 10 infants and children who showed no systemic reactions. Conditions demonstrated were congenital anomalies, polycystic kidneys, bifid pelves, horseshoe kidneys, solitary kidneys, hydronephrosis, hydroureter, renal tuberculosis and kidney tumors. The best shadows were obtained when the ureter was partially or completely blocked. The author states that no surgery should be attempted until a cystoscopic examination and a catheterization of the ureters has been carried out in each case with the usual bacteriological studies, function tests and determinations of the presence of pus and blood.—*C. L. Martin.*

Pescatori, Guido. Valore della esplorazione radiologica delle ghiandole surrenali nella malattia di Addison. (Value of roentgen examination of the suprarenal glands in Addison's disease.) *Arch. di radiol.*, Mar.–Apr., 1930, *6*, 364–372.

It is hard to see the suprarenals on roentgen examination but with perfect technique they appear as triangular shadows above the upper pole of the kidney and separated from it by a slender transparent line. The author describes a case of tuberculosis of the suprarenal capsule as illustrating the value of roentgen examination in Addison's disease. The patient was a man of thirty-eight who about four years before had had orchidectomy performed for tuberculous epididymitis on the right side. For about a year he had been suffering from weakness and apathy, headache and insomnia. He had all the other symptoms of Addison's disease including diffuse brown pigmentation of the skin, particularly the parts exposed to the sun. The kidneys were examined with a Potter-Bucky diaphragm in the ventrodorsal projection. While the right suprarenal capsule was only slightly visible and its outlines not very distinct, in the left one, the triangular outline of which could be seen clearly, there were three spots of varying opacity and with indistinct outlines. On the dorsoventral projection they were somewhat larger, showing that they were in the posterior part of the abdomen. It is generally impossible to determine definitely whether such calcifications are in the suprarenal capsule or in tissues immediately in front of or behind it. But in this case as they were within the outlines of the suprarenal capsule and in the posterior part of the abdomen, and as the patient had a typical Addison syndrome it seemed evident that they were in the suprarenal capsule.

There may be such calcifications in tuberculosis, old inflammations or tumor. In tumor the calcifications are generally larger, more homogeneous and the outlines more distinct, while in tuberculosis they are in the form of small granules of varying opacity, more or less in groups and with indistinct outlines. The picture in this case was more like that of tuberculosis and the patient had a history of tuberculosis of the testicle.

Few such cases have been described, perhaps partly because roentgen examination of the suprarenals is rarely made in Addison's disease. —*Audrey G. Morgan.*

Jona, J. Leon, and Flecker, H. Pyeloscopy—radioscopy of the kidney pelvis. *Surg., Gynec. & Obst.*, July, 1930, *51*, 50–55.

Tracings of intrarenal pressure changes recorded by a tambour and writing point connected to a ureteral catheter are compared with fluoroscopic and roentgenographic studies of the renal pelvis and the ureter rendered visible by opaque materials in both experimental animals and living patients. Normally the musculature of the kidney exhibits rhythmic contractions. The contraction begins in the upper calyx and the middle and lower calyces are observed to contract at intervals of one to three seconds. While the calyces are contracting the pelvis shows a steady relaxation. The communications with the calyces then close and the pelvis suddenly contracts with a snap-like action throwing a "globule" of its contents into the ureter. A peristaltic wave passes the globule downward, often with a lightening-like speed.

The action of various drugs on this sequence of events was studied. Atropin caused a relaxation of the kidney pelvis with pain in the human subject from over filling. Morphine, strychnine, eserine and pituitrin all produced contraction of the pelvis with instant relief of the pain produced by atropin. Histamine produced a relaxing effect along with a fall in blood pressure and vasodilatation. Ergot brought about a preliminary contraction followed by prolonged relaxation. Numerous clinical applications of these observations are cited.

Kidney pelves were ruptured experimen-

tally by increasing the intrapelvic pressure and the opaque material was seen to enter the veins. Pyelographic injections should always be stopped when the patient complains of pain since the limit of safety is rapidly being approached.—*C. L. Martin.*

SKELETAL SYSTEM

St. Kartal. Chondromatosis of the joint capsule. *Surg., Gynec. & Obst.*, July, 1930, *51*, 99–108.

This article deals with joints which in America are said to contain "joint mice." Numerous case histories accompanied by good roentgenograms are included. Conditions considered in the differential diagnosis are osteochondritis dissecans, myositis ossificans, calcified bursae, hemophilic joints and arthritis deformans. This form of chondromatosis is a disease entity rather than a secondary manifestation of some other disease. The etiology is uncertain but chronic irritation and trauma are probably involved. There are frequently no symptoms present and the progress of the disease is slow. Treatment is usually expectant unless the joint has a squeezed-in appearance in which event arthrotomy is performed with a removal of the free joint bodies.—*C. L. Martin.*

Alquier, A. Un cas de chondromatose articulaire du coude. (A case of articular chondromatosis of the elbow.) *J. de radiol. et d'électrol.*, August, 1930, *14*, 460–461.

Recently Solomon and Gibert have published a case of articular chondromatosis. This induced the author to report a similar case. The condition occurred in a man aged twenty-seven, who about fourteen years previously suffered an injury to the elbow. At the time of the examination several small tumors of the left elbow could be felt and the roentgenograms revealed numerous areas of increased density within the synovial cavity of the joint, resembling the picture of a chondromatosis.

The condition is rather rare. It is probable that the trauma was the provoking cause.—*T. Leucutia.*

Harbin, Maxwell, and Zollinger, Robert. Osteochondritis of the growth centers. *Surg., Gynec. & Obst.*, Aug., 1930, *51*, 145–161.

The authors find that the literature contains about 700 articles dealing with osteochondritis of the growth centers. An unbelievable number of names have been applied to the condition, a different group having arisen for each epiphysis involved. The disease occurs in either the primary or the secondary centers of growth during their periods of greatest activity and should be classified on this basis. Numerous case histories accompanied by good roentgenograms are included illustrating Legg's disease, Osgood-Schlatter's disease, Köhler's disease of the patella and tarsal scaphoid, the Larsen-Johannson syndrome, Freiberg's infraction of the second metatarsal, deformities of the vertebral bodies resulting in spinal curvature and round shoulders and other epiphyseal abnormalities. Etiology and treatment are discussed at some length. A simplification of terminology is urged by the authors.—*C. L. Martin.*

Dariaux, André. Luxation du semi-lunaire et fracture du scaphoïde. (Luxation of the semilunar and fracture of the scaphoid.) *J. de radiol. et d'électrol.*, August, 1930, *14*, 457.

A very brief case report with unusual upward subluxation of the semilunar and of the upper half of the fractured scaphoid. The roentgenograms are reproduced.—*T. Leucutia.*

Belot, J., and Mouchet, Albert. Anomalie d'ossification du col fémoral. (Anomaly of ossification of the femoral neck.) *J. de radiol. et d'électrol.*, June, 1930, *14*, 332–334.

The author recently had the opportunity to examine three dwarfs of Lithuanian origin. The youngest (eight years old) was affected with a typical osteochondritis of the right hip, while the two older (sixteen and eighteen years old) showed an interesting abnormality of ossification of the femoral necks.

The abnormality appeared on the roentgen films in the form of more or less parallel lines of the upper half of the femoral necks, giving the impression of stalactites. They were somewhat similar to the lines observed in "melorheosteosis," described by A. Léri as candle drippings, except that they appeared more regular and somewhat less dense.

The authors are unable to explain the significance of this anomaly. They do not believe, however, that it represents a distinct pathologic entity since no clinical symptomatology and not the slightest functional disturbance were observed.—*T. Leucutia.*

De Vecchi, Luigi. Singolari alterazioni di nuclei di ossificazione in feto sifilitico. (Unusual changes in the centers of ossification in

a syphilitic fetus.) *Radiol. med.*, May, 1930, *17*, 575–580.

The author found peculiar roentgen changes in the centers of ossification of the calcanei in a macerated fetus. The mother had suffered from a florid syphilis during pregnancy so the fetus was very severely infected. He was born at seven months. The roentgen examination did not show the usual Wegner's osteochondritis nor the periosteal inflammatory new-growths that are often seen in the syphilitic fetus. But in the centers of ossification of the calcanei on both sides there was a conglomeration of small points of calcareous opacity of the size of pinheads, without any bone structure; they were not perfectly round but rather semilunar. The whole group was stellate in shape, running toward a central nodule which was more intensely opaque and with which the points seemed to be connected by delicate bridges. Normally the center of ossification of the calcaneus is partly ossified in the fourth month of intrauterine life and at the seventh month is lenticular in form with a finely reticulate bone structure. Histological examination in this case showed that its structure was still cartilaginous, with many very small calcified areas. Apparently some rare kind of syphilitic dystrophy had retarded the development of the centers.—*Audrey G. Morgan.*

Freund, Ernst. Über die von Kreuz beschriebenen ungewöhnlichen Veränderungen an den Hüftkopfepiphysen. (Concerning the peculiar changes of the epiphyses of the femoral head described by Kreuz.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1930, *41*, 935–940.

Kreuz recently described "unusual disturbances of the epiphyses of the femoral heads in an adolescent" which he, on the basis of the roentgen findings, has considered as distinct from the changes observed in Perthes' disease. The author found at the Instituto Rizzoli a similar case which was observed by Professor Putti in 1926, the condition being classified as "non-Perthes." This case is now described in detail. The lesion occurred in a boy fifteen years of age who had diphtheria two years previously and who immediately following his convalescence started to develop a waddling gait. The roentgen examination revealed an aseptic bone necrosis of the epiphyses of both femoral heads, without demarcation such as is observed in osteochondritis dissecans. Because of the slight deformity of both heads of the femurs the condition resembled osteochondritis deformans juvenilis, a differentiation from this being impossible except on an anatomic basis.—*T. Leucutia.*

Kienböck, Robert, and Markovits, Emmerich. Ein Fall von Ostitis fibrosa cystica generalisata. (A case of osteitis fibrosa cystica generalisata.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1930, *41*, 904–919.

The authors describe a case of osteitis fibrosa cystica generalisata in lengthy detail. The case was first studied in 1924, at the age of seventeen, by Eppinger and Hitzenberger, and the second time recently by the authors. The initial symptoms appeared at the age of eight with waddle gait and signs of rickets. At the age of fourteen a hump developed. At the time of the first examination by Eppinger and Hitzenberger, the girl was small (143 cm.) and considerably undernourished. There was a hydrocephalus with marked deformity of the skeleton and with a dorsal kyphosis of the spine (gibbus). A clinical diagnosis of osteomalacia was made, but following a detailed roentgen examination of the entire skeleton this was changed to osteitis fibrosa cystica generalisata von Recklinghausen. For the next five years the patient received various treatments (stretching, implantation of thyroid gland, calcium and phosphorus regime, etc.). Although the general condition has shown rather marked improvement the disease itself continued to progress. Pathological fractures appeared at shorter or longer intervals. A re-examination by the authors five years later revealed practically no change in the height (142 cm. high), the hydrocephalus, the deformity of the bones and the gibbus. There was, however, on roentgen examination an increased calcification of the skeleton as a whole, although the cystic areas which were observed at the first examination have in places considerably increased in size.

The authors discuss in great detail the following points: the fibrosis of the spongious skeleton, the cyst formations, the location and character of the pathologic fractures, the osteomalacic deformities, the rachitic disturbances, the articular changes, the sclerosis, the retarded growth and the calcium metabolism. In comparing the two examinations it was noticed that the condition remained stationary in all except

the formation of cysts and the pathologic fractures, which have shown marked progression, and the sclerosis of the skeleton which, on the other hand, has shown improvement.

The prognosis is doubtful. A permanent healing with entire disappearance of all symptoms may result, or the lesion may slowly progress to a fatal end.

In résumé, the peculiarities of the case were: the onset during childhood, the repeated slow exacerbations, the marked osteomalacic deformities, the formation of large but not excessively expansive cysts with multiple spontaneous fractures, a marked pagetoid deformity of the skull, an involvement of the hands and a progressive tendency to healing. The duration of the disease is now over fourteen years.—*T. Leucutia.*

MACDONALD, RALPH. Pathological fractures. *Surg., Gynec. & Obst.*, July, 1930, *51*, 131–132.

A study of 1,405 fracture cases at the Massachusetts General Hospital discovered 24 pathological fractures. The average age of the patients was 38.1 years, but one was 9 months old and one was 66 years of age. The femur, tibia, humerus and clavicle were the bones involved in their order of frequency, the femur far outnumbering the others. The pathological conditions observed were Paget's disease, osteomyelitis, cyst, sarcoma, fragilitis ossium, metastatic carcinoma, syphilis, gumma and hypernephroma. Paget's disease and osteomyelitis occurred much more frequently than the other diseases. Frequently a spontaneous fracture was the first evidence of the disease. Union almost always occurs in the non-malignant conditions and may occasionally occur in the presence of malignancy.—*C. L. Martin.*

SOPHIAN, ABRAHAM. Diabetes insipidus and osteitis fibrosa polycystica. *J. Am. M. Ass.*, Aug. 16, 1930, *95*, 483–484.

A case is reported in which the above-named conditions were associated, the polyuria being very great and the bone lesions very extensive. The former was easily controlled by pituitary extract, which had no effect on the osseous disease, this being at variance with findings of previous observers. With the decalcification of the bones there was a very marked deposition of calcium in the lung fields, the blood calcium remaining normal. The question of the relation of osteitis fibrosa polycystica to hyperparathyroidism is raised.—*E. W. Hall.*

TUMPEER, I. HARRISON, and MCNEALY, R. W. Fragility and deficient healing of bone in poliomyelitis. *J. Am. M. Ass.*, July 5, 1930, *95*, 19–21.

A brief review of the opinions of others is followed by a report of two cases of fracture of bones in extremities exhibiting post-poliomyelitis paralysis. The authors' comments include statements that bone atrophy in poliomyelitis is indistinguishable from atrophy of non-use, that atrophic bones have increased fragility, and that while healing occurs with abundance of callus, union is weak due to lack of functional stimulus. Bone regeneration is not affected by nerve lesions.—*E. W. Hall.*

EDITORIAL. Renal rickets—an undesirable designation? *J. Am. M. Ass.*, July 12, 1930, *95*, 116.

Although renal insufficiency is well known to be the cause of retarded osseous development simulating the changes found in ordinary rickets, it is questionable whether the term "renal rickets" is aptly applied to this condition. The opinion is expressed that such a term may lead to errors in treatment, since the methods usually used in rickets are ineffective when the kidney disease is the underlying factor. "Renal infantilism" is suggested as a name for the disease, which name would suggest therapy directed toward the establishment of normal renal function.—*E. W. Hall.*

BERARD, L., and NOVEL. A propos des lésions squelettiques et articulaires chez les crétins myxoedémateux. (Concerning the lesions of the skeleton and articulations in myxedematous cretins.) *J. de radiol. et d'électrol.*, June, 1930, *14*, 329–331.

This article is a brief report of the roentgen findings of the skeleton and joints in a man thirty-nine years of age affected with disorders of the thyroid gland. There was a marked shortening of all the long bones with enlargement and deformity of the epiphyseal ends. The curious deformity of the upper epiphysis of the humerus led to a true humerus varus. There was a deformity of the calcaneus and astragalus. Both knees gave rise to a genu valgum due to flattening of the external femoral condyles. The chief lesion occurred in the hip-joints where there was a nearly complete destruction of the

femoral heads giving rise to coxa vara. The femoral necks were distorted, a thin bony projection implanted perpendicularly on the greater trochanter forming the only support. The trochanters showed zones of osseous dystrophy similar to those observed in cystic osteitis. Finally, there was marked thinning and atrophy of the inferior maxilla and protrusion of all cranial sutures. The sella turcica was not enlarged.

The opinion is expressed that the skeletal changes which were observed chiefly in the articular zones and which consisted of deformities, absorptions, and hyperostoses, were either congenital malformations or, more likely, developmental disorders of the epiphyseal cartilages, resulting in shortness of the diaphyses and irregularity of the epiphyses. The marked deformities and resorptions occurred only later, most probably as a result of pressure.—*T. Leucutia.*

Haguenau, Gally, and Bernard. Trois cas de tumerus primitives du rachis. Traitement favorable par les rayons X. (Three cases of primary tumors of the spine; successful result by roentgen rays.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1930, *18*, 330–333.

The authors briefly describe 3 cases of primary tumors of the spine which were favorably influenced by roentgen treatment. One of the cases has remained well now for a period of nearly four years. The treatment was carried out with penetrating roentgen rays (200,000 volts, 1 mm. Cu and 0.2 mm. Al as filters) by using the fractional method.—*T. Leucutia.*

Blount, W. P. Chondrodysplasia. *Am. J. Dis. Child.*, Aug., 1930, *40*, 327–333.

Blount states that chondrodysplasia was long thought to be a rare disease in America. Occasional cases were reported under such names as Ollier's disease, chondro-osteoma, multiple cartilaginous exostoses, ossified diatheses, rachitiform enchondrosis and dyschondroplasia. Ehrenfried described the condition in 1915 and collected the available cases, and since then its identity has been well recognized.

Blount reports a case, with excellent reproduction of the roentgenographic lesions, which had no exostoses. There was no familial factor. Many of the cartilage bones were involved in a dysplasia, with islands of cartilage in the osseous tissue near the growth centers. Curvature of the long bones and impairment of joint function resulted. The condition was coincident with a mild case of rickets, but no clue was furnished as to the etiology.

He quotes Stock's classification of multiple exostoses, and so regards Ollier's disease, (limitation of the dysplasia to one side of the body), merely as an interesting variation. Stock takes no account of distribution in his classification. —*R. S. Bromer.*

Ochsner, Alton, and Gage, I. M. Osteogenic sarcoma developed in osteitis deformans (Paget's disease of the bone). *Surg. Clin. N. Am.*, Aug., 1930, *10*, 851–868.

Attention is called to the fact that in the original description of osteitis deformans by Paget the possibility of malignant diseases being associated with the process was not only mentioned, but also emphasized. It was felt by Paget and other authors that individuals with osteitis deformans were more susceptible to malignant processes than other patients. Codman states that about 14 per cent of all cases of Paget's disease succumb to osteogenic sarcoma, while according to Kolodny, 5 per cent of osseous sarcomas registered in the Registry of Bone Sarcoma of the American College of Surgeons originated in bones involved with osteitis deformans.

It is almost universally agreed at the present time that sarcoma occurring in bones affected with osteitis deformans is the result of the previous osseous lesion and is not merely incidental. Kolodny is of the opinion that in the sarcoma developing on the basis of Paget's disease the tumor formation is the result of "local loss of growth restraint." This he considers of special importance in Paget's disease, especially when there is a constitutional weakness of general growth restraint.

The authors report a case of osteogenic sarcoma of the right tibia at the knee-joint occurring in a white male, aged sixty-one, who had extensive bone changes due to osteitis deformans. The patient had had an injury to the right knee a year before. Because of the extreme pain in the right knee and leg, a midthigh amputation was done. The patient died nearly two months later from an acute pulmonary infection. Autopsy showed sarcomatous metastases to the lung, liver, mesenteric and mediastinal lymph nodes.

The authors were able to collect from the

literature 31 cases of sarcoma developing in lesions of osteitis deformans. In 27 of the 31 cases in which the age was given the average for the series was fifty-four years. The sex of the patient was stated in 28 cases, 24 males (86 per cent) and 4 females (14 per cent). In the majority of cases only one bone was involved by the malignant process. The humerus was the site of the malignant lesion more frequently than any other bone.

The treatment employed was various, consisting of amputation, irradiation, Coley's toxin, curettage and local extirpation. The prognosis is invariably poor. The writers feel that in those cases in which there is considerable pain as a result of the malignant process, amputation of the involved extremity is justified in spite of the very grave prognosis.—*Karl Kornblum.*

FRASER, JOHN. A cystic dermoid tumor of the spinal cord. *Surg., Gynec. & Obst.*, Aug., 1930, *51*, 162–168.

A detailed case history is given of a young man who developed a chronic pain between the shoulders with radiation to the waist and groins at times. The discomfort was made worse by exertion. A few months later he noticed a weakness of the lower legs and found it difficult to control his feet while walking. His sleep was interfered with and he found it increasingly difficult to control his urine.

Sensory and reflex disturbances were elicited at physical examination which indicated the presence of spinal cord injury in the lower thoracic region. Ten cubic centimeters of lipiodol were injected into the spinal canal following a lumbar puncture. The patient was placed in an inverted position and anteroposterior and lateral films of the spine were made which showed an arrest of the lipiodol at the level of the eighth thoracic segment. At operation a cystic dermoid tumor about the size and shape of a date stone was found beneath the pia mater overlying the median fissure of the spinal cord posteriorly at the level of the ninth thoracic segment. The cyst walls were formed of a basement membrane lined with several layers of epithelium and it contained fat, cholesterin and many round, glistening, friable bodies.—*C. L. Martin.*

DILLENSEGER, R., and AUODUY, F. Goutte et rhumatisme goutteux. (Gout and gouty rheumatism.) *J. de radiol. et d'électrol.*, August, 1930, *14*, 449–456.

Three cases—the first, a chronic gout with marked symptomatology, the second, a suspected gout in which roentgen examination led to the correct diagnosis, and the third, a gouty rheumatism—are described in lengthy detail and illustrated with numerous roentgenograms.

The chief roentgen characteristics of true gout consist in rounded lacunes or vacuoles, localized chiefly to the epiphyses of the bones of feet and hands. The margins are sharp and the rarefied areas often surrounded by a thin hypertrophic zone of reaction. According to Lumière and Gélibert the sodium urate deposits gradually lead to absorption of the calcareous substances, giving rise to tophi. The articulation usually remains intact for a long period.

If the destructive process is associated with proliferative phenomena such as ecchondroses, marginal periostoses and erosions of the cartilage, these resulting in deformities, ankylosis, etc., one as a rule may be tempted to diagnose a rheumatic condition. It is the author's contention, however, that the osteophytes and exostoses in such instances, similar to those observed in arthritis deformans, tuberculosis, healed osteomyelitis, etc., are only the results of a local mechanical irritation produced by the sodium urate, gout forming the fundamental lesion. It seems, therefore, that "gouty rheumatism" would be a more appropriate term for the denomination of this complex.

The authors, in conclusion, emphasize the great value of roentgen examination in doubtful cases of gout, this often permitting a much earlier diagnosis than would be possible on the basis of clinical examination.—*T. Leucutia.*

PRUSSAK, LEON, and MESZ, NATAN. Über die idiopathische Osteopsathyrose. (Idiopathic osteopsathyrosis.) *Acta radiol.*, June 30, 1930, *11*, 175–193.

After a review of the literature on the subject, the authors describe 3 cases of their own, 2 of which showed the characteristic symptom-complex of that disease—brittle bones and blue sclerae. Case I was in a girl twelve years of age; two of her younger sisters and also her grandmother and her three brothers had blue sclerae but their bones were not brittle like those of the patient herself. There were no indications of any hereditary factor. The disease did not present a hereditary character in Case II either.

In both cases the bone changes characteristic of idiopathic osteopsathyrosis—abnormal thinness of the cortex, very soft spongy tissue and reduced calcium content—were very marked. In Case III a number of peculiar symptoms made the diagnosis of idiopathic osteopsathyrosis seem doubtful. The disease was accompanied by a chronic brain disorder that was hard to diagnose which was characterized by epileptic fits, fully developed imbecility and slight pyramidal symptoms. The article is illustrated by plates showing roentgenograms of the cases and followed by a bibliography.—*Audrey G. Morgan.*

Jacoby, Paul. Myelomatosis in a child of eight years. *Acta radiol.*, June 30, 1930, *11*, 224–225.

A girl eight years of age was admitted to the hospital with a diagnosis of spondylitis. For six months it had been difficult for her to hold her spine erect. Roentgen examination showed the bodies of all the vertebrae affected, those of the lumbar column most so. All of them were considerably flattened, most of them biconcave, almost hour-glass shaped. Several of them were distinctly wedge-shaped; all of them were very deficient in calcium and almost without structure. Many of the intervertebral spaces were wider than the vertebrae themselves. The child remained in the hospital for nine months, growing gradually weaker and toward the end increasingly anemic. No treatment had any effect and she finally died. Postmortem examination showed the cortex of the bodies of the vertebrae thin as paper and the interior of the bones a soft red mass apparently without any bony framework. Microscopic examination showed myeloma. The intervertebral discs were evidently able to expand on account of the softness of the bodies of the vertebrae and so changed the shape of the latter.—*Audrey G. Morgan.*

ROENTGEN AND RADIUM THERAPY

Voltz, Friedrich. Die Strahlenabteilung der Universitäts-Frauenklinik München. (The radiation division of the University Gynecological Clinic of München.) *Strahlentherapie*, 1930, *37*, 199–214.

Döderlein in 1913 began his work on radiation therapy of carcinoma of the female genitalia at the University Clinic in München. (This article as well as the twelve following are dedicated to Professor Dr. A. Döderlein on the occasion of his seventieth birthday.)

The author, who is head of the roentgen therapy department of the Döderlein Clinic, describes in detail the development of the department as well as its present arrangement. The article is illustrated with numerous photographs showing the general layout and the individual therapeutic units of the department.

It must be mentioned that since 1913 all uterine carcinomas have been treated by radiation therapy exclusively. Döderlein himself says in this respect that "the time has arrived when the so dangerous and radical operations must be abandoned."—*T. Leucutia.*

Heyman, James. Die Strahlentherapie als vollständiger oder teilweiser Ersatz der Operation bei der Behandlung von Karzinomen des Uterus, der Vagina und der Ovarien. (Radiation therapy as a complete or partial substitute for operation in the treatment of carcinomas of the uterus, vagina and ovaries.) *Strahlentherapie*, 1930, *37*, 254–265.

After publishing the statistics of the results obtained in the treatment of carcinomas of the female genitalia at Radiumhemmet, Stockholm, from 1914 to 1923, the author arrives at the following conclusions with regard to the therapeutic indications: In carcinoma of the cervix radiation therapy forms the method of choice. Only cases refractory to irradiation are submitted to operation.

Carcinomas of the body of the uterus are best operated on and then irradiated postoperatively. In the borderline cases it is often necessary to decide between operation and irradiation. If the enlarged uterus presents a large and irregular cavity operation is to be preferred, while in the cases in which the uterine cavity is narrow and regular radiation therapy is indicated.

In carcinoma of the vagina surgical treatment should be entirely replaced by radiation therapy.

In carcinoma of the ovary a combination of surgery and irradiation leads to best results.—*T. Leucutia.*

Recasens, S. Wahl der Behandlungsmethoden des Kollumkarzinoms hinsichtlich der klinischen und pathologisch-anatomischen Formen. (Choice of the therapeutic methods in carcinoma of the cervix on the basis of the

clinical and anatomico-pathologic forms.) *Strahlentherapie*, 1930, *37*, 266–274.

The author discusses the best methods of treatment for the various clinical and anatomico-pathologic forms of carcinoma of the cervix.

Clinically carcinoma of the cervix is divided into three groups: (1) when the carcinoma is completely localized; (2) when there is extension in the surrounding tissues, and (3) when there is generalization. In Group 1 either surgery or radiation therapy is indicated. The choice is left to the patient. If a woman is afraid of an operation and refuses surgical intervention, radiation therapy can be undertaken without fear of a reproach in case of an unsuccessful result. On the other hand, if the patient has decided on an operation, this always can be later supplemented by radiation therapy. From a histological standpoint a differentiation must be made between the basal cell carcinoma, which is more radiosensitive, and the squamous cell carcinoma, which is radioresistant. It is evident that radiation will lead to more favorable results in the first, while in the latter operation will be of greater benefit.

In the second group the use of radioactive substances can be advantageously combined with operation. First, one series of radiation therapy is given (radium and roentgen therapy) and five to six weeks later, if conditions permit, an operation is performed. As a rule the preliminary application of radiation clears up most of the infection and produces a decrease in the size of the tumor so that operation can be performed with greater ease.

In the third group, radiation therapy is the method of choice. If there is evidence of marked necrosis with secondary infection, cauterization (thermo- or galvanocautery) and caustics are often of great help.

It is the author's contention that a combination of radiation therapy and surgery in the operable cases leads to an 8 to 10 per cent increase in the cures as compared to the results obtained by either method alone.—*T. Leucutia.*

REGAUD, CL., and LACASSAGNE, A. Einige Fälle von radiotherapeutisch behandelten Uterussarkomen. (A few cases of uterine sarcomas treated by radiotherapy.) *Strahlentherapie*, 1930, *37*, 275–292.

Primary sarcoma of the uterus is rather rare (from 0.5 to 2 per cent of the malignant uterine tumors). The authors observed between 1919 and 1930 six cases of sarcoma of the uterus in a total of 1,000 uterine malignancies. These 6 cases are described in detail, the histological sections being reproduced in each instance. Three of the cases were spindle cell sarcomas, one leiomyoma sarcomatosum and 2 myxosarcomas.

All 6 cases were treated by radiation therapy (radium or a combination of radium and roentgen therapy). Only one remained well for a period of three and one-half years, while the others died within six months from the beginning of the treatment.

The conclusion is reached that radiation therapy is of little value in the treatment of uterine sarcomas. All operable cases should therefore be submitted to surgery. In the far-advanced infected cases radiation therapy must be carried out with great caution since, due to gangrene of the tumor produced by the radiation, a rapidly fatal outcome may follow such a procedure.—*T. Leucutia.*

v. JASCHKE, RUD. TH. Die Resultate der Behandlung des Uteruskarzinoms in den Jahren 1918–1930. (The results of the treatment of uterine carcinomas from 1918 to 1930.) *Strahlentherapie*, 1930, *37*, 293–301.

Three hundred and eighteen uterine carcinomas (223 cervix and 95 corpus) were treated between 1918 and 1930.

In carcinomas of the cervix all operable carcinomas were first operated upon and then irradiated with roentgen rays. The limits of operability were rather broad, 140 of the 223 cases (a total of 62.7 per cent) having been submitted to operation. Of these 130 cases were observed for a period longer than five years, the percentage of the absolute cure amounting to 23.8 per cent and that of the relative cure to 33 per cent. Of 95 corpus carcinomas, 67 (70 per cent) were operated upon, 46 of which were observed for a period longer than five years, giving 50 per cent absolute and 62.5 per cent relative cures.

The conclusion is reached that all carcinomas of the uterus which can be operated upon should be submitted to surgical intervention first and then irradiated. The results so obtained were considerably better than those obtained by irradiation alone.—*T. Leucutia.*

Weibel, W. Operieren und Bestrahlen beim Gebärmutterkrebs. (Operation or irradiation in uterine carcinoma.) *Strahlentherapie*, 1930, *37*, 302–310.

The author made a review of the literature on the best method of treatment to be followed in carcinoma of the uterus and found that through improvement in technique radiation therapy lately has brought the percentage of favorable results up to that obtained by surgery. He believes, however, that at least for the present surgical intervention should not be supplanted by irradiation. It is safest to operate first and to irradiate postoperatively (for a period of one to two years). In the inoperable cases a combination of roentgen and radium therapy is advised.—*T. Leucutia.*

Mayer, A. Bemerkungen zur "Vorbestrahlung" des Uterus-Kollum-Karzinoms. (Note on the preliminary irradiation of carcinomas of the cervix uteri.) *Strahlentherapie*, 1930, *37*, 311–321.

The methods used at present for the treatment of carcinoma of the cervix uteri are: (1) primary operation with postoperative irradiation; (2) irradiation alone and (3) preoperative irradiation with secondary operation. (1) The primary operation has two disadvantages: (*a*) it can be performed only on a very limited number of cases (30 to 35 per cent of the total material), and (*b*) it leads to a very high operative mortality (Döderlein, 20.3 per cent; Franz, 19.9 per cent, Berlin clinics, 14.1 per cent, etc.).

(2) Radiation therapy alone has several advantages: (*a*) it can be used also in the inoperable cases (Döderlein obtained an absolute cure of 10.7 per cent); (*b*) there is no operative mortality; (*c*) in beginning carcinomas it leads to better results than operation (Döderlein has obtained a cure of 40.5 per cent in Group I and 37.7 per cent in Group II), and finally (*d*) the uterus is maintained (Döderlein observed in one case the delivery of a normal baby).

(3) A preoperative irradiation followed by operation was carried out by the author in a limited number of cases. The results were very satisfactory. It was observed that because of the clearing up of the infection and the decrease in size of the tumor from the irradiation, operation could be carried out with greater ease, the primary mortality having been thus considerably reduced At the same time the percentage of the relative healing was increased. It is the author's contention that the best time for the operation is six weeks following the irradiation.

The conclusion is reached that the percentage of absolute cures is about the same for irradiation and operation. If only the early cases are considered, the results by irradiation are superior to those obtained by operation. In the more advanced cases and especially in the borderline cases, a preliminary irradiation followed by operation seems to lead to the best results. The number of cases so treated, however, is not sufficiently large to permit a final opinion.

It is remarkable that Döderlein who is one of the greatest masters of surgery has laid aside the knife in favor of radiation, which according to him must be the method of choice in the treatment of all carcinomas of the cervix.—*T. Leucutia.*

Schmitt, Walther. Über die Erfolge der Strahlenbehandlung beim inoperablen Kollumkarzinom. (The results of radiation therapy in inoperable carcinomas of the cervix uteri.) *Strahlentherapie*, 1930, *37*, 322–333.

Between January 1, 1913 and June 30, 1923, 163 cases of inoperable carcinoma of the cervix were treated by the author. In 77 of these radium alone was used, with a five-year cure of 10.4 per cent, in 72 a combination of radium and roentgen rays, with a five-year cure of 8.3 per cent, and in 14 roentgen radiation alone, with not one five-year cure. During the same period, 120 cases were treated by operation alone. Of these 48 have remained well for five years, giving a relative cure of 40 per cent.

Taking all cases into consideration the absolute cure is 20.3 per cent (62 out of 305 cases). —*T. Leucutia.*

Hubert, R. Zur Frage: Soll das operable Kollumkarzinom radikal operiert oder bestrahlt werden? (On the question: Should the operable carcinomas of the cervix be radically operated upon or irradiated?) *Strahlentherapie*, 1930, *37*, 334–340.

Three hundred and ninety-seven cases of carcinoma of the cervix were admitted during 1920 to 1929 to the gynecological clinic of the University Clinic of Greifswald. Of these 151 (38 per cent) were operable. In 10 the uterus was vaginally, in 28 abdominally extirpated and in 103 a radical Wertheim operation was performed (one case died before operation and 9 cases were treated primarily by irradiation).

I. The primary mortality was 12.6 per cent, occurring chiefly in patients afflicted with various extragenital lesions such as heart disease, hernia, intestinal rupture, pneumonia, cachexia, marked obesity, etc. Therefore the author advises that a radical operation be performed only in cases without extragenital complications, the rest being submitted to primary irradiation.

II. It is well known that adenocarcinomas, especially when occurring in the young, are very refractory to irradiation. These cases must be submitted to operation even in case of extragenital complications.—*T. Leucutia.*

Reisach, Anselm. Bericht über die Ergebnisse der von 1917–1927 operierten und strahlenbehandelten Genitalkarzinome und über einen geheilten Fall von Traubensarkom beim Kinde. (Report on the results of genital carcinomas operated upon and treated by irradiation between 1917 and 1927 and on a healed case of grape sarcoma in a child.) *Strahlentherapie*, 1930, *37*, 341–348.

Since 1917 the combined irradiation with radium and roentgen rays has been used systematically at the gynecological clinic of Dortmund for the treatment of all inoperable carcinomas of the female genitalia. Occasionally operable cases were also treated for the purpose of experimentation.

The number of cases of inoperable carcinoma of the cervix (Group III) treated by irradiation between 1917 and 1924 was 178, a relative cure of 10 per cent having been obtained. During the same time, 50 cases of operable carcinoma (12 Group I and 38 Group II) were primarily irradiated with a relative cure of 24 per cent.

In 60 cases primarily operated upon (57 with Wertheim operation) and 10 operated and irradiated a relative cure of 35 per cent was obtained.

The author also includes the cases treated between 1925 and 1927, the percentage of three-year cures being identical to that found in the above cases.

It is recommended that all carcinomas of the cervix be primarily operated upon and then treated by radiation. The author has had a rather unfortunate experience with preoperative irradiation, several of his patients having failed to return for the completion of the treatment.

During 1917–1925, 9 cases of carcinoma of the body of the uterus were observed, 6 of which were operated upon (4 remaining well) and 3 treated by irradiation (one remaining well).

Of 33 cases of carcinoma of the ovary only 2 have remained well (1 treated by operation and 1 by irradiation). Of 12 cases of carcinoma of the vulva, all have died, and of 9 cases of carcinoma of the vagina, 2 have remained well, both being treated by a combination of radium and roentgen rays.

In conclusion, the author describes a case of an unusual grape-like sarcoma of the vagina observed in a child two years of age. Following curetting of the tumor masses and application of radium (600 mg-hr.) eight days and again (540 mg-hr.) three weeks later, a cure was obtained which has lasted for a period of over three years.—*T. Leucutia.*

Keller, Fr. Die Prognose des Adenokarzinoms des Collum uteri bei Strahlenbehandlung. (Prognosis of adenocarcinoma of the cervix treated by radiation therapy.) *Strahlentherapie*, 1930, *37*, 349–353.

Three hundred and ten cases of carcinoma of the cervix were observed at the gynecological clinic of the University of Freiberg during 1915–1925, 5 of which (1.62 per cent) were of the adenocarcinoma type. The 5 cases are briefly described. During 1926–1929, in a total of 153 carcinomas of the cervix, 4 additional adenocarcinomas (2.6 per cent) were found.

The conclusion is reached that adenocarcinoma of the cervix is rather rare. In none of the cases treated was there a permanent cure, the average life duration amounting to 15.4 months. —*T. Leutucia.*

Kaboth, Georg. Über die isolierte Radiumapplikation auf den Fundus uteri (Fundusverödung). (On the isolated radium application to the fundus uteri (fundus atresia).) *Strahlentherapie*, 1930, *37*, 354–360.

The author describes two types of radium applicators for the uterine cavity constructed so as to produce a necrosis of the bleeding mucosa and later on atresia of the uterine cavity. One of the applicators is for the action on the upper portion of the fundus, while the other is for the action on the whole of the uterine mucosa. The dose of complete amenorrhea amounts in a normal-sized uterus to 1,000, 1,200, 1,500 mg-hr. In enlarged uteri or fibromyomas this can be correspondingly increased.

Between the ages of twenty and thirty an attempt must be made to stop the bleeding with a dose of 400 to 800 mg-hr. Only if this proves insufficient should a larger quantity of radium be used.—*T. Leucutia.*

Gaessler, E. O. Über die Auswirkung der Röntgen- und Radiumbestrahlung im Stoffwechselbild von Gebärmutterkrebskranken. (On the effect of the roentgen and radium irradiation on the metabolism of patients afflicted with uterine carcinoma.) *Strahlentherapie*, 1930, *37*, 361–377.

The author gives a tabular arrangement of the various chemical reactions (pH, surface tension, viscosity, freezing point, clotting time, alkali reserve, plasma volume, etc.) of the blood serum in 9 patients with carcinoma of the cervix treated by radiation.

An alteration of the blood chemistry was observed in most of the patients suffering with uterine cancer. In those in which the application of radiation led to healing, the value of the reactions—with few exceptions—returned to normal. As soon as there was recurrence or further progress of the lesion the alterations became more pronounced. Thus a decrease of the alkali reserve, a reduction in the surface tension, an increase in the plasma volume of the total albumin, an increase in the fibrinogen, globulins, fats and potassium was observed as a rule. In a few instances the amino acids, lactic acid and the blood sugar were also increased.—*T. Leucutia.*

Lacassagne, A. La Radiothérapie des épithéliomas du col utérin à l'Institut du Radium de Paris. (Radiotherapy of epitheliomas of the uterine cervix at the Radium Institute of Paris.) *Arch. Inst. du Radium de l'Univ. de Paris*, 1930, *2*, 95–132.

Summary. This article presents the results obtained by radiotherapy of epitheliomas of the cervix uteri during the first five years of activity of the therapeutic departments at the Radium Institute of Paris (1919–1923).

The working conditions (radioactive and roentgen therapeutic material, hospital equipment, organization of the departments) are explained first. The physical and biological principles actually followed in the treatment of epitheliomas of the cervix uteri are then discussed.

The following rules are observed: (1) all epitheliomas of the cervix uteri which can be irradiated in good conditions are treated by radiotherapy alone, whatever their degree of extension; (2) the cases operated upon include: (*a*) the adeno-epitheliomas; (*b*) certain pavement-celled epitheliomas presenting unfavorable conditions for irradiation (signs of concomitant adnexal infection, lack of distention of the vagina, etc.) and (*c*) the recurrences after curie therapy.

In the cases of Stage I curie therapy forms the sole method of treatment. In the others, transcutaneous radiotherapy, by telecurie or roentgen therapy, is always combined with intracavitary curie therapy. The different techniques are described in detail.

The five-year results are given in the form of tables. Radiotherapy alone has given 42 per cent cures for Stage I, 28 per cent for Stage II, 10 per cent for Stage III and no cure for Stage IV, making an average of 20 per cent for the total cases treated.—*T. Leucutia.*

Laborde, Simone, and Wickham, Yves-Louis. La radiothérapie du cancer du col de l'utérus au centre anticancéreux de la banlieue Parisienne; statistiques des anées 1921 ä 1926. (Radiation therapy of cancer of the uterine cervix at the anticancer center of the suburbs of Paris; statistics of 1921 to 1926.) *J. de radiol. et d'électrol.*, July, 1930, *14*, 402–412.

Carcinoma of the cervix is divided into four groups: Group I—lesions limited only to the cervix, the so-called operable cases; Group II—juxta-uterine involvement with partial mobility of the uterus, the so-called borderline cases; Group III—involvement of the parametria or part of the vaginal wall with fixation of the uterus, the so-called inoperable cases, and Group IV—forms with generalized involvement.

The number of cases treated and the percentage of cures for the various years are as follows:

1921—11 cases, cured 8 years later, 18.1 per cent
1922—26 cases, cured 7 years later, 19.23 per cent
1923—25 cases, cured 6 years later, 16.0 per cent
1924—31 cases, cured 5 years later, 22.58 per cent
1925—30 cases, cured 4 years later, 33.33 per cent
1926—50 cases, cured 3 years later, 18.0 per cent

If the cases are classified according to the stage of involvement, the following is the percentage of cures: (1921–1924) five-year cures: Group I, 80 per cent; Group II, 55.5 per cent; Group III, 16 per cent; Group IV, 0 per cent.

The technique of irradiation was as follows: In Group I curie therapy alone was used; in

Groups II and III curie therapy was associated with roentgen therapy; in Group IV roentgen therapy alone was employed.

The radium therapy consisted: (1) in the introduction of two or three radium tubes of 20 mg. radium element each (filtered with 1 mm. platinum and 3 mm. rubber) into the uterine cavity; (2) in the placement of three radium tubes of 10 mg. each (screened by 1.5 mm. platinum and 1 cm. gauze), one radium tube in each lateral cul-de-sac and one directly on the cervix. The radium was left in situ for a period of seventy to seventy-five hours; from 6000 to 6300 mg-hr., that is, 46 to 50 millicuries-destroyed. In case of sphacelation of the carcinoma, the radium treatment was divided into two halves given at five to six days intervals. The authors have given up the interstitial application of radium needles within the tumor mass. If the radium therapy was associated with deep roentgen therapy, the latter was applied previous to the insertion of the radium. Four to five ports of entry were used, a dose of from 4000 to 4500 R (Solomon) per portal being administered at a distance of 40 cm. with 1 mm. copper and 2 mm. aluminum filtration. A total dose of 16,000 to 20,000 R was given over a period of fifteen to twenty days, 1000 R having been applied daily. More recently the authors used telecurietherapy with 1 gram of radium, 1 mm. lead filter, 12 cm. distance (erythema being obtained in forty hours), the number of fields depending on the extent of the carcinoma.

In the treatment of the far-advanced cases, special attention was paid to the infection. A combination of vaccine and serum therapy was used during the administration of the roentgen therapy, previous to the insertion of the radium.

In discussing the surgical indications, the authors state that in France there is still a tendency to perform hysterectomy whenever possible. The above statistical results as well as those published by other institutions clearly show that radiation therapy is superior and therefore will eventually replace surgical procedures.—*T. Leucutia.*

REGAUD, CL. L'Organisation et les conditions d'efficacité de la lutte contre le cancer de l'utérus. (The organization and the conditions of efficiency in the fight against cancer of the uterus.) *Arch. Inst. du Radium de l'Univ. de Paris*, 1930, *2*, 81–94.

Summary. Whatever the method of treatment, the cure of uterine cancer depends on two factors: early diagnosis, early and correct treatment.

Early Diagnosis. The means of facilitating early diagnosis consist in: (*a*) propaganda among the public; (*b*) propaganda among doctors and mid-wives and improvement in their gynecological instruction; (*c*) advice and practice of periodical examinations. The diagnosis of uterine cancer demands numerous organizations for consultation. Histological analysis is one of the means which must be used. It is not necessary that each organization possess a laboratory; it is enough that they have connections with the laboratories of large hospitals or medical schools.

Correct Treatment. Agreement has not yet been reached concerning either the choice of therapeutic methods or the technical details. This will be accomplished only when irreproachable statistics are available in sufficient number. Radiotherapeutic methods have not yet been stabilized. It is therefore useless to stress at the present time unity of opinion in the matter of correct treatment.

Principles of Organization. The cure of cancer of the cervix uteri by irradiation is difficult, especially so when the lesions are advanced. The procedure, although it appears simple, is very complicated in its practical application. The administration of the radiation by physicians and hospitals which have not sufficient material or training is not to be recommended. The loaning of radium and the sale of radon to individual practitioners leads to bad results. It is desirable that treatments by radiotherapy be restricted to a small number of special institutions having both clinical and scientific facilities. The large gynecological or surgical clinics not specializing in radiotherapy but still wishing to make use of it should be in close association with scientific institutions.

The possession of a large amount of radium distributed in good applicators, an adequate and powerful organization for roentgen therapy, the hospitalization of the patients and a staff of collaborators competent for the various needs, are indispensable for the cure of cancer of the cervix uteri in a satisfactory proportion. —*T. Leucutia.*